THE RAILROAD AND ENGINEERING JOURNAL.

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ANNOUNCEMENT.

ON the completion of the present volume of the RAILROAD AND ENGINEERING JOURNAL, and beginning with the number for January, 1893, the title under which it has been published since 1887—when the old *American Railroad Journal* and *Van Nostrand's Engineering Magazine* were consolidated—will be changed to THE AMERICAN ENGINEER AND RAILROAD JOURNAL.

The chief reason for making this change is that the present title is somewhat cumbrous, is lacking in definiteness, and is not easily remembered. It has been found that many persons familiar with the JOURNAL, and even those who are regular readers of the paper, do not readily recall its name, and that it is often difficult to identify it by its title alone. At the time of the consolidation of its progenitors the name which would have been preferred to any other, for the new publication, was THE AMERICAN ENGINEER, but at that time a paper with that title was published in Chicago. Since then it has been discontinued, and therefore the name may now be assumed by us if we are disposed to adopt it. For the reasons given it has been determined to make use of that privilege; and although a change in the title of a periodical publication is attended with obvious—but, it is thought, merely temporary—disadvantages, it is believed that they are not so great as the detriment resulting from the continued use of a name which is not sufficiently distinctive and is difficult to recall.

It must be understood, however, that the change of name does not imply any change of control; nothing but the title of our late cotemporary has been adopted, and the ownership and the editorial staff of the paper will continue the same as heretofore.

The new name will indicate distinctly the character which this publication is intended to have. It was announced in the first number of the RAILROAD AND ENGINEERING JOURNAL that it "will be devoted to the discussion of engineering and mechanical subjects. Railroad construction and operation being, however, the most important branches of engineering in this country, more space will be devoted to them than to any other one department of engineering." The general scope of the paper under its new title will not be materially changed. Its form and size will remain the same, but new type and a quality of paper better suited for the printing of process engravings will be used. It is intended to have a larger proportion of original articles than heretofore, and to make material improvements in the character of the illustrations published.

Among the articles already provided for, it may be mentioned that Dr. Dudley's interesting series of Contributions on Practical Railroad Information will be continued; and Mr. Chanute's on Progress in Flying Machines will also be continued and concluded. Fully illustrated descriptions of locomotives, cars, stationary and marine engines, shop appliances and practice by different builders will be given from time to time.

A series of articles on what may be called Comparative Anatomy of English and American Locomotives will be commenced in the January number. These will be illustrated by very complete detailed engravings showing the construction of the engines and of the different parts or organs of the most recent express locomotives built for the London & Southwestern Railway, and of the engine with 7-ft. driving-wheels now running on the New York Central & Hudson River Railroad, an illustration of which was given in the November number. These illustrations will be fully described in critical articles comparing the construction and performance of both engines. This discussion will be continued through the greater part of the year 1893, and will, it is thought, give a better idea of the peculiarities of construction of both English and American locomotives than it is possible to obtain from any existing source. Engravings of all the different parts of the two engines will be printed on opposite pages, which, with the description and criticism that will be given, will greatly facilitate a comparison of the different methods of construction employed in this country and in England, and of their relative advantages or disadvantages.

Other new features will be added to the paper from time to time, and it will be the aim of its editors and proprietor to make the rechristened paper such a record of the work of the AMERICAN ENGINEER as shall be a warrant for the use of that title.

EDITORIAL NOTES.

ALL subscribers to the RAILROAD AND ENGINEERING JOURNAL should receive with the present number the Index and Title-page for Volume LXVI (Volume VI, New Series). Should any fail to receive it, they can have the omission supplied on notifying this office. The volume covered by this index includes the twelve numbers for the year 1892.

ANY subscribers who may wish to have their volumes for 1892 bound can do so by sending their files to the office, No. 47 Cedar Street, New York, by mail or express, prepaid, and remitting the sum of $1.25. The bound volume will be returned to them, at their expense, without delay.

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Any special style of binding or any lettering desired may be ordered, for which only the actual extra cost over the regular price will be charged.

THE present season, with its long drought extending through the fall, when rain is usually abundant, has been a severe test for the water works of quite a number of the smaller cities and towns of the Eastern States. Some of them have stood it, while a few have not, and in many cases there has been a narrow escape. It too often happens with towns of moderate size that, while the works themselves are well planned, not enough care is taken to investigate the sources of the water supply or to provide storage for a dry season. The supply is good at first, perhaps for two or three years, but a long drought comes, the source fails, and the resulting expense is greater by far than would have been required for a proper provision in the first place. Instances enough could be given, and in one case in mind a rapidly growing suburban town has lost by a check to its increase and a corresponding depreciation of property more than ten times the amount that a proper system with a sufficient supply would have cost.

THE enlargement of the Chesapeake & Delaware Canal so as to permit the passage of large sea-going vessels through its locks is urged by Professor Haupt, with much force in an article quoted in another column. There are few improvements of equal extent which could be made for so small a sum, and which would yield so valuable a return. In connection with the proposed ship canal between New York Bay and the Delaware and the enlargement of the canals south of Norfolk, it would furnish a waterway which will certainly be of great service to commerce, and which might be of inestimable value in case of war.

THE armor for the barbette of the *New York* has now been tested and accepted, and it is said that work on her completion can proceed without further delay.

The coast defense ship *Monterey* at San Francisco will be ready for the trials of her engines in December. She is the first large ship of the Navy in which a large part of the steam power is furnished by tubulous boilers.

IT is claimed that the best time on record was made on the evening of November 18 on the Central Railroad of New Jersey by one of the large Vauclain compound passenger engines, which were illustrated and described in the JOURNAL for June last. On the evening in question the engine, running with a regular train, consisting of a combination car, two day coaches and a Pullman car, ran one mile, near Fanwood, N. J., in 38 seconds, and the succeeding mile in 37 seconds; or at the rate of 94.74 and 97.30 miles per hour respectively. The engine had previously made a mile in 39 seconds. At the time of the run there was a high wind.

THE electrical engineers are indirectly responsible for a number of recent improvements in the steam-engine. The demand for quick-running and reliable engines for working dynamos for electric lighting and similar purposes has stimulated the activity of engine-builders, and been the occasion for improvements of different kinds. This state of affairs promises to continue for some time to come.

THE use of the compound and triple-expansion engines and of higher boiler pressures has had a tendency to increase the use of water-tube, coil and other similar forms of boilers. The influence of this can be traced in the number of patents for such devices recently patented, and in other similar ways. The tubulous boiler will undoubtedly have a very large part among the steam producers of the future, and any improvements in its design and structure are welcome.

OUR electrical friends have also stimulated the construction of dams and the utilization of water-powers. Many water-powers are situated in remote places where it is difficult or impossible to build mills, or if sites can be found, the cost of haulage to and from the mill would be a source of too great expense. But with late improvements in electrical transmission it is only necessary to find room enough for the water-wheel and dynamo, and the power can be taken to any convenient point.

THE builder and designer of great bridges find in Russia almost as wide a field to work in as in this country. In the size of the rivers and, in fact, in many of the physical features, that country bears a considerable resemblance to the United States. We find, as might be expected, that many bridges of great length have already been built there, and others are projected. In many respects American practice in bridge-building has been closely approximated, and Russian engineers do not hesitate to acknowledge their obligations to their American brethren.

It may be added that the Siberian Railroad, when completed, will have some of the largest bridges in the world.

IN no country has irrigation been so carefully planned and so widely practised as in British India. Irrigation works have existed there for many centuries, and have more recently been extended under English engineers. Some of the largest rivers have been dammed either to divert their flow or to furnish storage, and there are dams in that country far exceeding in size anything yet planned here. Some of these works approach three miles in length, and there are a number of almost equal dimensions. On another page will be found an account of some of these structures.

PROPERTY IN IDEAS.

A VERY little experience in life or study of history or human nature soon teaches us that the predatory passion in mankind is very strong, and the command, "Thou shalt not steal," although it was promulgated some thousands of years ago and has been zealously inculcated ever since, has, up to this time, not made hen roosts inviolable, strong boxes unnecessary, or given to railroad and other securities the character implied by their name. It is true that among civilized people only the very ignorant and vulgar steal chickens; but bank robbers are of a higher grade of intelligence, and are regarded as more respectable. Those who wreck railroads often move in the higher walks of society, and are not entirely excluded from the Church. If a person steals a material thing of little value he is a vulgar thief; if he carries away money, he is a daring robber; and if he unjustly transfers the title of property to himself, he is a shrewd operator. In all these cases the thief gets possession of material property by predacious means, and the degree of infamy which is attached to the act somehow seems to be in the proportion which the materiality of the thing stolen bears to its value. If there is much material and little value, as in the case of chickens, the theft is considered very reprehensible and vulgar. If there is little material stolen, as in the case of money or

jewels, and much value, it is somewhat less disgraceful; and if no actual material thing is carried away, but only a title to something is taken, many people are prepared to condone the offense and admire the shrewdness of the malefactor. To a still greater extent does this feeling exist when we deal with property in ideas. There are not many *raconteurs* who are scrupulous about telling other people's good stories or clever sayings as their own, and what a man writes is considered public property unless the author can protect his rights by the authority of the copyright laws. In fact, the recognition of the right to intellectual property implies a more than ordinary development of the mental and moral faculties. It has been said, and many people think, that there is no natural property in ideas which are evolved from the depths of the inventor's or author's consciousness; and these cheap and miraculous products should therefore be at the disposition of all who may desire them for their own use. Or, as Herbert Spencer says: *

> There are not wanting philanthropic and even thinking men who consider that the valuable ideas originated by individuals —ideas which may be of great national advantage—should be taken out of private hands and thrown open to the public at large.
>
> To this an inventor might fairly reply: "Why may not I make the same proposal respecting your goods and chattels, your clothing, your houses, your railway shares, and your money in the funds? . . . True, as you say, this capital, on the interest of which you subsist, was acquired by years of toil —is the reward of persevering industry. Well, I may say the like of this machine. While you were gathering profits I was collecting ideas; the time you spent in conning the prices current was employed by me in studying mechanics; your speculations in new articles of merchandise answer to my experiments, many of which were costly and fruitless; when you were writing out your accounts I was making drawings; and the same perseverance, patience, thought and toil which enabled you to make a fortune have enabled me to complete my invention. Like your wealth, it represents so much accumulated labor; and I am living upon the profits it produces me just as you are living upon the interest of your invested savings. . . . If I have no right to these products of my brain, neither have you to those of your hands; no one can become the sole owner of any article whatever, and 'all property is robbery.'"

The same author says "that a man's right to the produce of his brain is equally valid with his right to the produce of his hands is a fact which has yet obtained but a very imperfect recognition."

It is often objected to patents that they are "monopolies." The word "monopoly" is derived from two Greek words meaning *alone* and *to sell*, and signifies "the exclusive right to sell." A writer on patent law † defines a monopoly as "a franchise created by the Government, and vesting in an individual or corporation the exclusive privilege of practising a certain art, or of making, using or selling a certain article, which but for such monopoly all other individuals and corporations would be at liberty to practise, or to make and use and sell." Such monopolies were granted in monarchical governments as rewards for service rendered, and in this manner nearly all commercial operations eventually became restricted under the protection of such exclusive grants; and as another writer on patent law ‡ says: "In the grants of the crown the subject-matter of the exclusive privilege was quite as often a commodity of which the public were and long had been in possession as it was anything invented, discovered, or even imported by the patentee." When an exclusive franchise is granted to an inventor, instead of taking anything from the public, he confers on it the greatest benefits. Judge McLean, in a decision made in 1855, said that:

> Patentees are not monopolists. This objection is often made, and it has its effect upon society. The imputation is unjust and impolitic. A monopolist is one who by the exercise of the sovereign power takes from the public that which belongs to it, and gives to the grantee and his assigns an exclusive use. On this ground monopolies are justly odious. It enables a favored individual to tax the community for his exclusive benefit, for the use of that to which every other person in the community abstractly has an equal right with himself. Under the patent law this can never be done. No exclusive right can be granted for anything which the patentee has not invented or discovered. If he claims anything which was before known his patent is void. So that the law repudiates a monopoly. The right of the patentee entirely rests on his invention or discovery of that which is useful and which was not known before. And the law gives him the exclusive use of the thing invented or discovered for a few years as a compensation for his ingenuity, labor and expense in producing it. This, then, in no sense partakes of the character of a monopoly.

The ground upon which patents for inventions are granted was very clearly stated by an English judge as long ago as 1602, who said:

> That when any man by his own charge and industry, or by his own wit or invention, doth bring any new trade into the realm, or any engine tending to the furtherance of a trade that never was used before—and that for the good of the realm— that in such cases the king may grant to him a monopoly patent for some reasonable time until the subjects may learn the same, in consideration of the good that he doth bring by his invention to the commonwealth; otherwise not.

That there are some great abuses which are carried on under the protection of the patent laws is true; but this is the case with all laws, and there has been for years past a very strong opposition to all patent laws. This opposition has come from large corporations, who want freedom to use the inventions of others without paying for them, and from a part of the agricultural communities in the West, who have had some unjust demands made on them for the use of patents, and also have had the feeling that agricultural machinery and other products would be cheaper if they were not patented. The question comes up perennially whether it is wise and just for the Government to stimulate the exercise of inventive talent, or, in the words of the Constitution of the United States, "to promote the progress of science and useful arts by securing, for limited times, to authors and inventors the exclusive right to their respective writings and discoveries." An answer to this inquiry may be given by asking what object inventors would have to invent if they could not have exclusive possession and control of their inventions? In other words, if there were no patent laws, inventors would stop inventing. To quote from a writer * on "The Nature of Intellectual Property:" "Whatever serves to increase that element of eager foresightedness that keeps men exploring every dark place in the line of social advance for the means of good or the remedies of evil that may be found there adds to the rate at which it gains on the difficulties which beset its advance." The patent law offers to original discoverers or inventors certain exclusive rights to their inventions and discoveries. This is a perpetual stimulant to those whom Mr. Shaler says "are stamped by nature with the fitness therefor, and have the capacity for great fixedness of attention and the training in imagination or suggestiveness which is required in order to meet the continued difficulties of an advance into unknown paths. . . . To retain this spirit of experiment and investigation which lies at the bottom of our Ameri-

* "Social Statics."

† William C. Robinson, LL.D., "The Law of Patents."

‡ Curtis on Patents.

* N. S. Shaler.

can inventiveness, we must, in the first place, *maintain the inducements that lead men into this* sort of life. These inducements are the monetary prizes that it affords." It would seem as though the progress of the English-speaking nations, but especially ours, and the development of inventions here would be a great object lesson to prove the indebtedness that civilization owes to the systems of patent law which exist in these countries.

"It is a well-proved fact," Herbert Spencer says in the book already quoted from, "that that insecurity of material property which results from general dishonesty inevitably reacts to the punishment of all. . . . From general distrust spring general discouragement, apathy, idleness, poverty, and their attendant miseries, involving alike all grades of men. Similar in kind and less only in degree is the curse attendant upon insecurity of property in ideas. Just in so far as the benefits likely to accrue to the inventor are precarious will he be deterred from carrying out his plans."

A recent book * contains what Mr. Spencer calls a "strong illustration of the fact that the moral sense, when unguided by systematic deduction, fails to find its way through the labyrinth of confused opinion to a correct code of duty." In the book referred to the author said that in 1840 he took out a patent for steeling the surface of rails and tires, and adds:

> This patent did not pay me during the whole of its time more than between £5,000 and £6,000, and I found so much trouble connected with it and the false position I felt placed in with our own company that I never took out another, nor do I ever approve of engineers who have to advise large companies being themselves interested in patents. I look upon the patent law as a great curse to this country. It cannot be worked with perfect honesty. (What law can?) Patents are taken out for all kinds of absurd things, and by people with little or no practical knowledge of the work they undertake, and the really practical man in carrying out his work is met at all points by the claims of some patentee. I have in my practice constantly found the disadvantage of the law, not that I object to reward a man for a real invention, but the real inventors are rare, while the patents are counted by thousands. The absence of a patent law would not retard invention. The human mind will scheme and study for the pleasure of the work, and the honor of being the originator of a real improvement would be a sufficient stimulus.

That Sir Daniel may have felt placed in a "false position" with his company, which he was paid to advise, if he recommended the use of his own patented invention can easily be understood; and he was also right in not approving of engineers who have to advise large companies being themselves interested in patents, especially for inventions they must advise about. A consulting engineer certainly ought not to "blind his eyes" by "turning aside after lucre" which might "pervert his judgment." In this respect, as in many others, he ought to "avoid the appearance of evil." It may be true, too, that so distinguished an engineer may at times, in carrying out his work, have been met by the claims of patentees, and that, from his point of view, this was a "disadvantage." Doubtless he may have encountered similar difficulties in the titles of other parties to real estate that he or his company desired to occupy, but in such cases he did not look upon the laws governing the ownership of real estate as "a great curse." He respected the rights of owners of such property, but felt it a hardship that he was compelled to regard the titles of inventors to their "property in ideas." That the human mind would scheme and study for the pleasure and honor of the work, even if there were no patent laws, may in a certain sense be true, but that they would do so with as much intelligence, energy and persistence without as they do with is surely not true.

To quote once more from Herbert Spencer:

> Did mankind know the many important discoveries which the ingenious are prevented from giving to the world by the cost of obtaining legal protection, or by the distrust of that protection if obtained—were people duly to appreciate the consequent check put upon the development of the means of production—and could they properly estimate the loss thereby entailed upon themselves, they would begin to see that the recognition of the right of property in ideas is only less important than the recognition of the right of property in goods.

That a very large proportion of inventors exercise their ingenuity on matters of which they are profoundly ignorant any one who has had much to do with them will soon discover. It is not easy to see, though, how patents could be limited so as to include only those which cover devices of practical value. It is true that the law says an invention must be new and *useful*; but who shall decide on the usefulness of all the contrivances which are patented weekly? It may be that in the future the courts and the laws may make a stricter application of the limiting word "*useful*," and that an inventor may be compelled to show the usefulness of his invention before a patent is granted. It is true, too, that there is a constant stream of frivolous inventions issued by the patent office, and that much intercourse with inventors will not increase one's estimate of their wisdom; but with all the defects in the system, the fact remains that it has the effect—which it was intended to have—of stimulating invention, and that modern civilization owes a great deal to the recognition of property in ideas.

* "Diaries of Sir Daniel Gooch, Bart."

THE ROAD QUESTION.

A NEW petition to Congress is now being widely circulated for signature. It has been started by Colonel Albert A. Pope, of Boston, who has been very active in urging discussion of the road question, and in preaching the Gospel of Good Roads, and asks for the establishment in Washington of a Department of Roads, a permanent exhibition and an institute for the instruction of engineers in road work.

Without intending to diminish at all the importance of improving our roads—which we have always strongly urged—it seems that this petition asks too much. The Agricultural Department might well establish a special bureau to aid in road improvement and to co-operate wherever possible in the work now being done in the different States, and indeed there is no special work to which its activity could be better directed; but there does not appear to be any occasion for setting up the machinery of an entire department with a secretary at its head. Moreover, the question is under State regulation, and too much bureau interference might do more harm than good.

To the collection of a permanent exhibition of road machinery and methods there can be no possible objection; but this could readily and properly be done under the charge of the Agricultural Department with but little additional legislation. Under proper management such an exhibition could be made of much service.

To the establishment of an institute for the instruction of road engineers it would seem also that valid objections could be made. It is not the proper business of the Gov-

ernment to train up engineers, with the exception of the few who are needed for the special purposes of the military and naval establishments. It is, unfortunately, true that too many engineers from our present technical schools know little or nothing about road work, but an appeal to Congress is not the proper remedy. The continuation of the present agitation and discussion of the question will do much by drawing the attention of the technical schools to the fact that they have, with some honorable exceptions, neglected the question, and by showing engineers themselves how wide a field there is opened to them in road construction if they possess, or will acquire, the necessary knowledge.

The agitation of the road question should be continued, and support is due to every proper effort to further it; but the petition referred to certainly seems a step in a wrong direction, to which attention should be called.

RAILROADS OF THE WORLD.

FROM a paper presented at the recent meeting of the International Railroad Congress, it appears that at the beginning of 1891, the latest date to which all the necessary statistics could be procured, there were 617,285 kilometers —383,581 miles—of railroad in operation in the world.

America is the continent which has reached the greatest development in this direction, having no less than 54 per cent. of the railroads of the world. The United States had 268,400 kilometers; Canada, 22,531, and the Argentine Republic, 9,000.

Europe has 36 per cent. of the railroad mileage. In that continent Germany leads with 42,869 kilometers; France is second with 38,895; Great Britain third with 32,297; Russia fourth with 30,957, and Austria-Hungary fifth with 27,113 kilometers. If the ratio of railroad mileage to the number of inhabitants is taken, however, the European countries rank very differently. Sweden stands first, having 16.8 kilometers to 10,000 population, and Switzerland comes second with 10.9 kilometers to 10,000 people. France, Denmark, Germany, Belgium and Great Britain are not far apart, their ratios being respectively 9.6, 9.4, 8.7, 8.6 and 8.5 kilometers to 10,000 persons; while Russia has only 3.2 and Turkey 2.0 kilometers to 10,000 inhabitants.

The great continent of Asia has only 5½ per cent. of the world's railroad mileage, and this is chiefly concentrated in a few countries. Outside of the railroad system of British India, 27,000 kilometers, some 2,300 kilometers in Japan and the Russian Trans-Caspian line of 1,450 kilometers, we find only 1,310 kilometers in the Dutch colonies, 200 kilometers in China, and a few scattered lines in the French, Spanish and Portuguese colonies.

Africa, like Asia, has its railroads concentrated in a few countries. Algeria and Tunis have 3,100 kilometers; the Cape Colony, 3,000; Egypt, 1,544; Natal and the Transvaal about 600. The "Dark Continent" can claim only 1½ per cent. of the total.

The railroad mileage of Oceanica, with the exception of a short line in the Hawaiian Islands, is found entirely in Australia and the adjacent islands. The total is 3 per cent. of all the railroads in the world.

The total amount of capital invested in railroads is estimated at $32,600,000,000; an average of about $85,000 per mile.

NEW PUBLICATIONS.

THE FINANCIAL SECURITY OF LOCAL RAILROAD CONSTRUCTION IN AUSTRIA. By Sigmund Sonnenschein. Vienna, Austria; A. Hartleben.

In Austria, as in nearly all the other countries of Europe, there has been for two or three years past much discussion over the building of local or secondary railroads. The term by which these roads are described has hardly come into use in this country, though we long ago accomplished the fact, and all our leading roads have large systems of branch lines and feeders auxiliary to their main trunks. In Europe, however, it seems to be thought necessary that a fixed system for the building and management of such roads should be established and formulated on a distinct basis. Both plans, perhaps, have advantages of their own.

Mr. Sonnenschein's little book gives some interesting facts in relation to the local roads of Austria, and treats of their claims as an investment for capital. He has collected much information as to the working of those already established, and his book may present some points of interest to managers who have to deal with lines of this class.

THIRD ANNUAL REPORT ON THE STATISTICS OF RAILROADS IN THE UNITED STATES TO THE INTERSTATE COMMERCE COMMISSION. Henry C. Adams, Statistician to the Commission. Washington; Government Printing Office.

In the JOURNAL for February last there was published from advance sheets some extracts from this report, with tables of general statistics and an account of the method adopted by the Statistician for grouping the figures by divisions covering various sections of the country. The complete report has now appeared in a bound volume containing 984 pages, or nearly twice as many as the report for the preceding year.

The number of railroads included shows that the Interstate Commission is now receiving reports from substantially all the railroads in the country. We have frequently referred to advantages of having such statistics collected by official authority, and to the opportunity offered of giving such a general view of the railroad business of the country as had not heretofore been possible. To a certain extent the report does take this opportunity; but, unfortunately, much is lost by the late date at which it appears. The present volume only covers the year ending June 30, 1890, so that its figures are over two years old, and of the time that has elapsed we have no information. The collection and tabulation of reports are very slow processes, it is true, but it is to be hoped that the force at the command of the Commission may be so increased as partly to remedy this.

In many respects the tables are well arranged and the information given is as full as possible. The collection of figures for any one road from the report is, however, a slow work, as a number of tables must be gone over in each case.

Apart from these defects, the report has great value, and the succeeding years are likely to increase this, as improvements are made with each volume.

SIMPLE LESSONS IN DRAWING FOR THE SHOP. By Orville H. Reynolds, Chief Draftsman Northern Pacific Railway. Terre Haute, Ind.; the Debs Publishing Company.

This little book belongs to the class of what are called "practical" books. It is 4¼ × 6¼ in. in size, and contains only 83 pages. The exercises and examples are all good, but the directions are hardly full enough to serve alone as a guide to a learner of mechanical drawing. If, however, a youthful aspirant for mechanical fame begins with this book, he may be led to further knowledge. In the hands of an apprentice it will in this way have the effect of awaking an ambition for more knowledge of the subject of which it treats, and that will then be an

important point gained. The instruction in it is all good as far as it goes, but there is not much of it.

A TREATISE ON HIGHWAY CONSTRUCTION. *Designed as a Text-book and Work of Reference for all who may be Engaged in the Location, Construction or Maintenance of Roads, Streets and Pavements.* By Austin T. Byrne, C.E. Illustrated, 723 pages; price, $5. New York; John Wiley & Sons.

A great deal has been written about roads, streets and pavements, but most of the existing publications treat of only one branch of the subject or are fragmentary papers scattered through the proceedings of technical societies and the pages of technical journals, where it costs much time and trouble to find them. Mr. Byrne has carefully collated the great mass of existing information on the subject, and has presented the result in the present volume, which he has endeavored to make a comprehensive book of reference.

How great an amount of labor has been done and how thoroughly the subject is covered may be indicated by a list of the chapter titles, as follows: Pavements; Materials for Paving; Stone Pavements, Wood Pavements; Asphaltum and Coal Tar Pavements; Brick Pavements; Broken Stone Pavements; Miscellaneous Pavements, Foundations; Resistance to Traction; Location of Country Roads; Width and Transverse Contour; Earth Work; Drainage and Culverts; Bridges, Retaining Walls, Protection Works, Tunnels, Fencing; City Streets; Footpaths, Curbs, Gutters; Reconstruction and Improvement of Country Roads; Maintenance, Repairs, Cleaning and Watering; Trees; Staking out Work; Specifications and Contracts; Implements and Prices.

Of the 723 pages about 240 are devoted to city streets and pavements and 245 to country roads, the remainder being occupied by general topics more or less applicable to both classes of works. The book is fairly well illustrated, and a very full index adds to its value.

Upon the whole it may be said that the author has done a service to engineers and others engaged in road work by preparing this volume. It is a better—because more recent—and a much more comprehensive book than any which we have on the subject. Some slight defects may be found, perhaps, and the closing chapter on Implements might be improved; but on the whole it is a valuable book and should find a place in the engineer's library. It will also be an excellent book for road leagues and improvement associations who wish to temper their zeal with knowledge, and to know how a road should be made as well as how it ought to look when it is done. Its appearance is timely, as interest in the road question grows rapidly in many directions.

THE LOCOMOTIVE ENGINE AND ITS DEVELOPMENT. *A Popular Treatise on the Gradual Improvements made in Railway Engines between the Years* 1803 *and* 1892. By Clement E. Stretton, C.E. London, England; Crosby, Lockwood & Son.

The author of this interesting little book is a well-known writer in English and to some extent in American technical papers, and for years has been contributing information to the public relating to the early history of locomotives. The book is 5 × 7½ in., and contains 154 pages. Of course in this space nothing like a complete history of locomotives could be given. It contains 79 engravings, beginning with Trevethick's locomotive, built in 1803, and ending with Mr. Webb's *Greater Britain*, built last year.

The book can hardly be called a "treatise;" it is more properly a popular sketch of the history of locomotives, but a very interesting one. It commences with the first beginning of locomotives, and contains engravings of Trevethick's, Blenkinsop's, Hedley's and Stephenson's early engines. This period may be called the infancy of the iron horse. During this time, as the author says, "Locomotive engines had simply been employed by private colliery owners for conveyance of coal upon their own lines." In 1825 the Stockton & Darlington, the first public railway in the world, was opened for traffic. This was the beginning of the second or youthful period of locomotive development. In this part of the book engravings and descriptions are given of Stephenson's engines, *Locomotion*, *Experiment*, *Twin Sisters*, *Lancashire Witch*, Hackworth's *Royal George* and Foster, Rastrick & Company's *Agenoria*, which "was exactly similar to the *Stourbridge Lion*," the first locomotive which ever ran in this country.

The third period, or the adolescence of locomotive development, began with the celebrated Rainhill trial. The *Rocket*, *Novelty* and *Sanspariel*, the three engines which competed for the prize, are all described. These are succeeded by many illustrations of locomotives which were built soon after this trial, all of which are very interesting.

The third chapter covers the period of the "Battle of the Gauges," when the advocates of the 7 ft. and the 4 ft. 8½ in. gauges competed with each other in the speed of their trains and the size of their locomotives. It was the time when large driving-wheels were very much in vogue, and a number of these are shown in the engines which are illustrated.

Chapter IV describes and discusses Modern Locomotives for Main Line Trains. In this the principal types of locomotives now used on English lines are illustrated and described.

Chapter V is on Sundry Appliances. The steam sand blast, the injector and the Joy valve-gear are discussed here. A good index completes the work.

Altogether persons interested in locomotive engines will find it one of the most readable books on that subject which has ever been published. It is written in a popular style, which is very simple and plain. The author, happily, has avoided any attempt at fine writing, and has told the story of the wonderful development of the locomotive in a very simple and plain way. It is to be regretted, though, that the engravings are not better than they are. Some of them are "process" cuts of that ragged character which makes one regret that the "process" of producing them was ever discovered.

It would, too, have added very much to the interest and value of the illustrations of the older engines if the original source from which the illustrations have been copied had been given. Some of them obviously are not authentic. That of Stephenson's Killingworth engine, on pages 12 and 13, with connecting-rods, cross-heads and guides like spider-webs, is obviously inaccurate, as the mechanism, if made as it is proportioned in the illustration, would be impossible. The engraving of the *Locomotion*, on page 17, is plainly not a copy of an actual machine, but is made from a drawing—and a very poor one—of a "scheme." Notwithstanding these defects the book possesses so much interest that they will be excused on reading what the author has written. There is abundant room for amplification, however, and it is to be hoped that some time in the future he will give the public a more elaborate and complete history of locomotives, in which the evolution of their different organs may be described. Such a work offers a very tempting field to any writer with a knowledge of locomotive engineering and a taste for antiquarian research.

CURRENT READING.

THE November number of the JOURNAL of the Military Service Institution is an unusually full one. There are articles on Guns and Forts, by Colonel King; Cavalry Equipment, by Lieutenant Cole; Water Supply in Desert Campaigns, by Lieutenant Beckurts; Skobeleff's Last Campaign, by Captain Clark; Recruiting Experiences, by Lieutenant Hawthorne;

the New Infantry Drill Regulations, by Lieutenant Crane; Artillery Service in the Rebellion, by General Tidball; and a variety of reprints and translations.

The November number of the NORTH AMERICAN REVIEW, besides several political articles, gave its readers papers on the Scandinavian in the United States, by Professor Boyesen; What Cholera Costs Commerce, by Erastus Wiman; Waste Products Made Useful, by Lord Playfair; Quarantine at New York, by Dr. Jenkins; Ernest Renan, by Robert G. Ingersoll; and several minor papers, by writers of standing. Two short papers on the share which Europe means to have in the Fair at Chicago next year, written by our Consuls-General at Berlin and St. Petersburg, will find many readers.

The leading article in the POPULAR SCIENCE MONTHLY for December is a continuation of Dr. Andrew D. White's series on the Warfare of Science. The title of this one is From Magic to Chemistry and Physics, which will indicate its subject. Deafness and the Care of the Ears is treated by Dr. A. M. Fanning, and Arthur Kitson writes of the Fallacies of Modern Economists. Some shorter articles make up a very interesting number.

The October number of GOOD ROADS has a number of excellent articles and is well worth attention.

With the November number the ARENA closed its sixth volume. In its three years of life this magazine has made a place for itself, and has gained the respect of the reading and thinking public. It is strong and aggressive, speaking without hesitation on subjects of the highest public interest, and it has always something to give the reader which will claim his careful consideration.

The first number of the new volume shows no decrease in interest and presents an excellent table of contents.

A recent addition to the list of technical journals is TRANSPORT, a weekly published in London. A large part of its space is devoted to harbors, canals and water-ways, but it has also something to say about railroads and ship-building. The articles are generally short; but the numbers before us manage to give a great deal of information in a condensed form.

The October number of GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE has, besides a continuation of the Columbus articles, papers on Social Life in China; the Wind as an Erosive Agency; the North Carolina Coast; Movements of the Earth's Crust; Origin and Diffusion of Cholera; besides several others of general interest. This magazine always has a number of articles which will interest the reader, besides those of special geographical value.

In the number of HARPER'S WEEKLY for November 2 the opening ceremonies of the Chicago Exposition are described and illustrated. The same number also has an illustrated description of the City of Mexico. The number for November 7 continues the Exposition illustrations, and has also illustrated papers on the Milwaukee Fire, on the Chicago Lake Front, and on Christiania, the capital of Norway. An article on Electric Railroads gives some interesting statistics.

The December number of SCRIBNER'S MAGAZINE is the holiday number, and is notable for the number of short stories and the excellent illustrations. More solid matter is not lacking, however, and there are articles on Norwegian and French Painters, on the German Entry into Paris, and on the Chicago Exposition Buildings, which are just now a central point of interest.

In the OVERLAND MONTHLY for November a second paper on the University of California is timely, as it gives a careful account of the observatory and its management, which has recently been the subject of much criticism; some excellent illustrations accompany this paper. An illustrated description of the Santa Lucia Mountains in Monterey County treats of a part of California as yet but little known. The Fisheries of California are discussed by Professor David Starr Jordan, and a short but interesting article describes the Siwash Indians of Puget Sound, a peculiar people.

The December number of HARPER'S MAGAZINE is a Christmas number, and is largely given up to short stories and illustrations; some of the latter are very fine specimens of the engraver's art. This number opens the 86th volume of this magazine.

The November number of OUTING is bright and seasonable, and the illustrations are of excellent quality. Among the articles in this number are Yumi, the Japanese Long-bow, by Robert G. Denig; Through Darkest America (continued), by Trumbull White; Battles of the Football Season of '91, by Walter Camp; Bicycle Riding in Germany, by Fanny B. Workman; A Day with the Quail, by Ed. W. Sandys; A Thanksgiving Day's Bear-Hunt, by H. S. Habersham; A Moot Point in Track Athletics, by John Corbin; National Guard of New Jersey (second paper), by Lieutenant W. H. C. Bowen, U. S. A.; Round the World with Wheel and Camera (continued), by Frank G. Lenz; Sturgeon Fishing in Russia, by Robert F. Walsh; and the usual editorials, poems, records, etc.

In the ECLECTIC MAGAZINE for November there are some excellent articles, including New Japan, from the *Fortnightly Review*; Storage of the Nile Flood, from *Blackwood's Magazine*; Growth of Industrial Peace, from the *Contemporary Review*; Where did Columbus First Land? from the *Nineteenth Century*; and a good selection of minor articles from the English periodicals.

In the November number of the ENGINEERING MAGAZINE there are articles on Light in Tall Office Buildings; Industrial Development of the South; Progress in Wood Working; City Hall Architecture in America; the Geological Survey; What Engineering Owes to Chemistry; Relative Cost of Gas and Electricity; the Mississippi Problem; the Electric Motor and the Farmer; Business Opportunities in Cuba; and the usual special departments. The number is well illustrated.

BOOKS RECEIVED.

Our Share in Coast Defense. Part I.: the 12-inch Breech-loading Rifled Mortars. Providence, R. I; the Builders' Iron Foundry. Some extracts from this pamphlet will be found on another page.

First Report of the Bureau of Mines of the Province of Ontario, 1891. Toronto, Ont.; published by order of the Legislative Assembly.

Modern Locomotive Construction. By J. G. A. Meyer. Cloth, 1,030 illustrations. Price, $10. New York; John Wiley & Sons.

Annals of the Italian Society of Engineers and Architects: Number IV, Volume VII, August, 1892. Rome, Italy; published by the Society.

Transactions of the Canadian Society of Civil Engineers: Volume VI, Part I: January–June, 1892. Montreal; published by the Society.

Transactions of the Technical Society of the Pacific Coast: October, 1892. San Francisco; published by the Society.

Proceedings of the Fifth Annual Convention of the Train Dispatchers' Association of America; held at New Orleans, La., June 14–17, 1892. J. F. Mackie, Editor. Published by the Association.

Proceedings of the Engineers' Club of Philadelphia: Volume IX, No. 4; October, 1892. Philadelphia; published by the Club.

Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department, relative to the Imports, Exports, Immigration and Navigation of the United States for the Quarter ending June 30, 1892. Hon. S. G. Brock, Chief of Bureau. Washington; Government Printing Office.

Transactions of the American Institute of Electrical Engineers: Volume IX, Nos. 7 *and* 8; *July and August*, 1892. This number contains the papers read at the general meeting in Chicago in June last.

TRADE CATALOGUES.

ALL subscribers who are interested in history should take advantage of the offer made on another page by Mr. A. O. Norton, of Boston, to send them an engraving of the Original Jack carried on board the *Ark* by Captain Noah. We have been favored with an advance copy, and must say that from internal evidence we believe that it is an excellent and faithful representation. It is accompanied by some engravings of jacks of later date.

Inventive Progress. Benefits of the American Patent System. William A. Rosenbaum, New York.

This handsome pamphlet contains some general remarks on the patent system, the nature of patents and the kind of inventions which are patentable. It is illustrated by views of the Patent Office and portraits of a number of noted inventors.

Illustrated Catalogue of Machinists' Tools. F. E. Reed & Company, Worcester, Mass.

This catalogue illustrates and describes a great variety of lathes of different sizes and also several patterns of milling machines. Most of these are of forms well approved by use, but improvements are not by any means excluded.

The Heating of Railroad Shops. The Huyett & Smith Manufacturing Company, Detroit, Mich.

This little pamphlet contains illustrations of the Smith hot-blast apparatus, with views and plans of several large shops heated by this device. The hot-air system has many features to recommend it, and it can often be applied where no other plan can well be adopted. For shops with a large open area it seems especially well fitted.

Some Facts of Interest in Regard to Sargent's Automatic Smoke Preventer. Sargent & Greenleaf, Rochester, N. Y.

This pamphlet describes and illustrates Mr. James Sargent's device for burning bituminous coal; giving also some records of tests and experiences had with it. The prevention of smoke from bituminous coal has been the object of many inventions, and this one seems to have attained a very fair degree of success.

1. *List of Gearing.* 2. *Illustrated Catalogue of Turbine Water Wheels.* 3. *Shafting, Pulleys and Hangers. The Robert Poole & Son Company, Baltimore, Md.*

These catalogues show a great variety of work. The especial department in which the company named does the largest work is machinery for the transmission of power, as indicated by the catalogues named. This does not cover all its work, however, for a large amount is done in its shops on cable railroad plants and on special machinery of the heaviest class.

Cylinder Lubricators, Grease-cups, etc. Catalogue No. 2. The Lackawanna Lubricating Company, Scranton, Pa.

This catalogue contains well-illustrated descriptions of the cylinder lubricators and other devices made by the company named, which is comparatively new, but is building up a considerable business by excellence of work and careful attention to details.

The United States Metallic Packing Company. Philadelphia, Pa.

This very neatly printed and bound book contains illustrated descriptions of the various kinds of packing made by this company for locomotives, stationary and marine engines. This packing is well known and widely used; and the company's book gives the strongest possible certificate to its excellence in the shape of a list of users which occupies a number of closely printed pages. It includes railroads, manufacturers and engine-builders in all parts of the world, showing how far this packing has made its way.

General Illustrated Catalogue, No. 27. *The Huyett & Smith Manufacturing Company, Detroit, Mich.*

This handsomely illustrated pamphlet contains descriptions of a great variety of apparatus made by the company named. These include dry-kilns, brick dryers, hot-blast apparatus, ventilating fans, blowers for various purposes, engines, marine water-tube boilers, dust separators, cotton fans, exhaust fans, steam traps, blast gates, etc.—a pretty comprehensive list. After a study of this catalogue one can appreciate better than ever before the variety of purposes to which the fan blower can be applied.

Approved Elevating and Conveying Apparatus. The Link-belt Machinery Company, Chicago.

This handsome catalogue gives descriptions and illustrations of several kinds of link-belting and their application to different purposes. The link-belt has been introduced in so many places and has served the purposes for which it was devised so well, that it is now generally known, and any description here would be superfluous. For elevators and for conveying machinery generally it seems to be replacing the old appliances wherever it becomes known.

The Link-Belt Company does a large business in machinery for the transmission of power, as well as for elevating purposes; and some reference to this will also be found in the catalogue.

Price List of Supply and Repair Parts, Electric Railroad Apparatus. October, 1892. *The General Electric Company, New York.*

The General Electric Company. Bulletin No. 1,003: *Railroad Power Generators. Bulletin No.* 1,004: *W. P. Railroad Motors. Issued by the Company.*

SOME CURRENT NOTES.

THE Russian Trans-Caspian Railroad, it is announced, will be extended from its present terminus at Samarcand northeast about 200 miles to Tashkend, an ancient city and the commercial center of Eastern Turkestan. The building of this extension will take about two years and will be under the charge of General Annenkoff, who was the engineer of the older portion of the line.

A further extension is under consideration, from Tashkend to Khokand, about 150 miles. It is probable that construction work will be continuous until the road reaches the eastern frontier of China.

THE deepest well in Europe is an experimental boring made at Schladebach, Germany, in the prosecution of some geological researches. This boring has reached a depth of 5,717 ft., over a mile, but the results so far obtained have not been important.

THE next international exposition after Chicago's is to be held in Antwerp in 1894. Preparations have already been begun, and a site has been chosen for the buildings. This will take the place of the exposition which it had been proposed to hold in Brussels in 1895. It is possible, however, that the date of the Antwerp exposition may be changed to 1895.

THE railroad line from Jaffa to Jerusalem, which has been lately opened for business, is 54 miles in length. At present the journey takes three hours, but when the road is fully in order and the road-bed settled a decrease in time to two hours will be made.

The company has the concession for several lines and work has already been begun on two branches. The first starts from the main line at Ramleh and will be built this year to Naplouse, 31 miles; this road is the beginning of a line to Damascus and Upper Syria. The second branch also starts from Ramleh and is to run to Gaza, about 47 miles; from Gaza it will be extended hereafter to El Arich on the frontier of Egypt.

A NEW use for aluminum has been found by a French inventor, who places a very thin plate of the metal between the two thicknesses of leather in the sole of a shoe. If the plate is made thin enough it will not make the sole too stiff; the metal will keep out moisture and will add to the warmth of the foot.

IT is stated by Herr Reinhardt Mannesmann that the addition of a small percentage of tungsten to aluminum increases its tensile strength to a remarkable degree. This tungsten-aluminum alloy also possesses the quality of resistance to the effects of water alone, of salt water and of impure water, showing no signs of oxidization even after long submersion.

A NEW oil field has been discovered in Sumatra, and from test borings it is thought that oil will be found over some 400 square miles of country. Wells already bored at Langkat are yielding from 3,000 to 4,000 barrels a month. The oil is reported as much better than that from the Baku wells in Russia and equal to good Pennsylvania oil. The oil district lies on the coast, where shipments are easily made. The Dutch colonial authorities have granted many concessions for wells.

SOME trials have been made on the Metropolitan Railway, in London, of Anderson's system of ventilation. A rectangular tube is laid between the rails. This has valves on top, which are opened by the locomotive as it passes. At intervals on the line are stations where exhaust fans draw out the smoke, gas, etc., from the ventilating pipe and discharge it through a chimney into the outer air. On the section fitted with this apparatus it has worked well enough to encourage the company to make further trials.

THE Waddell-Entz storage battery is to be tried on the Second Avenue Railroad, in New York. The batteries will be placed under the seats, each car carrying 100 cells, weighing 2,700 lbs. in all. A modified type of the Gramme hollow ring motor will be used, one placed on each axle.

AN artesian well has been sunk at Galveston, Tex., to the depth of 3,071 ft. without obtaining water. The pipe sunk is 22 in. for 57 ft.; then 15 in to a depth of 870 ft.; 12 in. to 1,500 ft.; 9 in. to 2,363 ft., and 6 in. to the lowest point reached. The borings showed in succession 46 ft. of gray sand; 18 ft. of red clay and shells; 36 ft. of blue clay mixed with shells and fragments of rotten wood; 218 ft. of sand, shells and wood; 497 ft. of sandy clay; 473 ft. of clay mixed with sand, shells and rotten wood, and below that strata of sand and clay with some large logs. At the bottom the drill struck a bed of shells.

The city of Galveston has a number of artesian wells from 825 to 1,350 ft., but the water is unfit for domestic purposes, though it is used in boilers, etc. The experiment just made cost the city $75,000.

THE new cruisers *Raleigh* and *Cincinnati* have about the same displacement and armament as the "M" class of cruisers of the British Navy, the *Davoust* of the French Navy and the Italian *Giovanni Bausan*. The "M" cruisers have been very unfortunate, having had many accidents, due chiefly to defects in design. The boilers and machinery were too light, and some structural weakness was developed also. The general opinion has been that strength was sacrificed to secure speed. This mistake, it is believed, has been avoided in our own ships.

A NEW freight engine, lately completed at the Crewe shops of the London & Northwestern Railway, has 20 × 24-in. cylinders and four 51-in. wheels all coupled. She has a long boiler with two sets of tubes and combustion chamber in the center of the barrel, similar to that of the *Greater Britain*, which was illustrated in the JOURNAL a short time ago.

THE sum of $5,000 has been given by the Emperor of Germany to build a balloon for military purposes, and $2,000 more for conducting experiments. The balloon will be 56 ft. in diameter, and will hold about 90,000 cub. ft. of gas. It will be used, if successful, in military reconnoisances and in taking scientific observations.

THE south jetty, or breakwater at the mouth of Galveston Harbor, is now completed for 24,600 ft. from the shore. It is built of large stones carefully selected and piled up. Work on the north jetty has just been begun.

It is found that these jetties are already beginning to have a remarkable effect on the channel, the sand at the bottom being scoured out by the force of the currents.

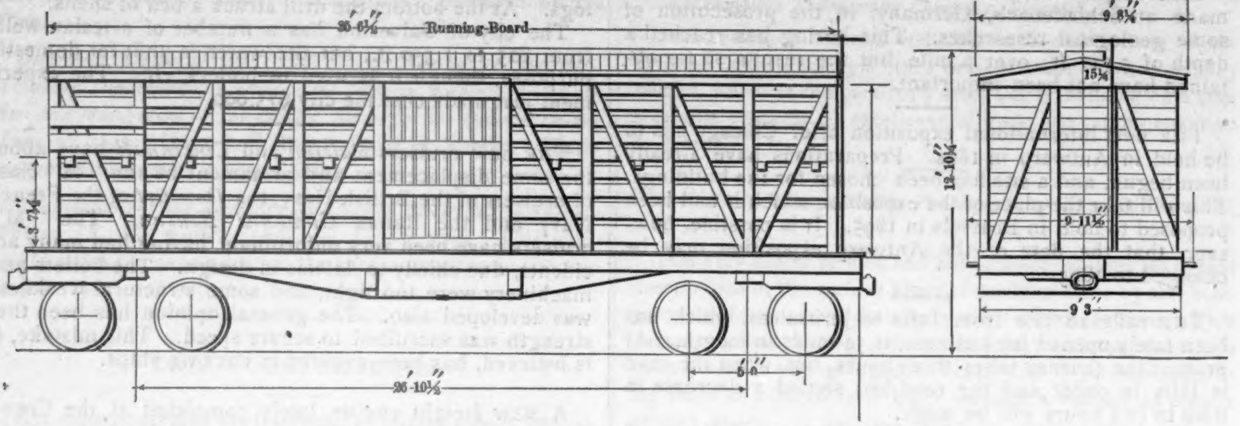
FROM recent data furnished by the surveying parties in the field, the Intercontinental Railroad Commission reports that the construction of a railroad from a port on the Caribbean Sea through Colombia, Ecuador and Peru to Lake Titicaca, on the western border of Bolivia, is entirely practicable. The distance is 2,800 miles, and the line traverses in part the great Andine plateau, the ascent to which can be made by works of moderate cost. The country has great natural resources as yet only partially developed.

The parties in Central America have nearly completed the preliminary lines through Nicaragua and San Salvador, and are now at work in Costa Rica.

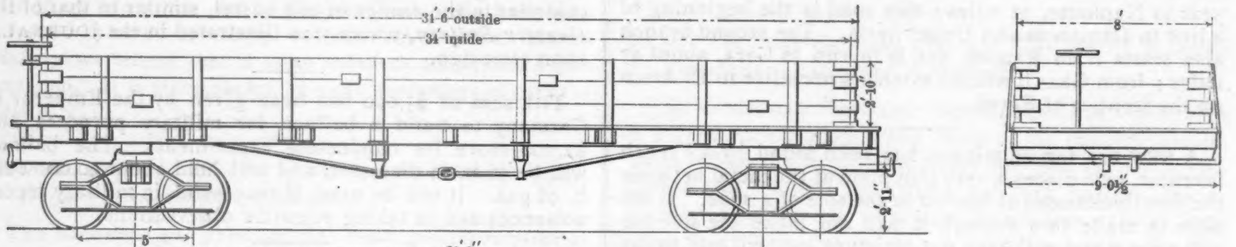
SOME recent experiments made in Austria seem to show that mild steel cooled to a temperature of 100° below zero opposes quite as much resistance to bending and fracture as at ordinary temperatures. The tests were made with small bars under a falling weight, and in every case the bending and permanent set were less with the cooled bars.

A LARGELY signed petition to Congress for the establishment of a Bureau of Roads is to be presented at the next session. The petition is being widely circulated, and has already received many signatures. The maintenance of an Institute of Road Engineering for popular instruction in this question is also proposed, as well as a permanent exhibition of road material and machinery.

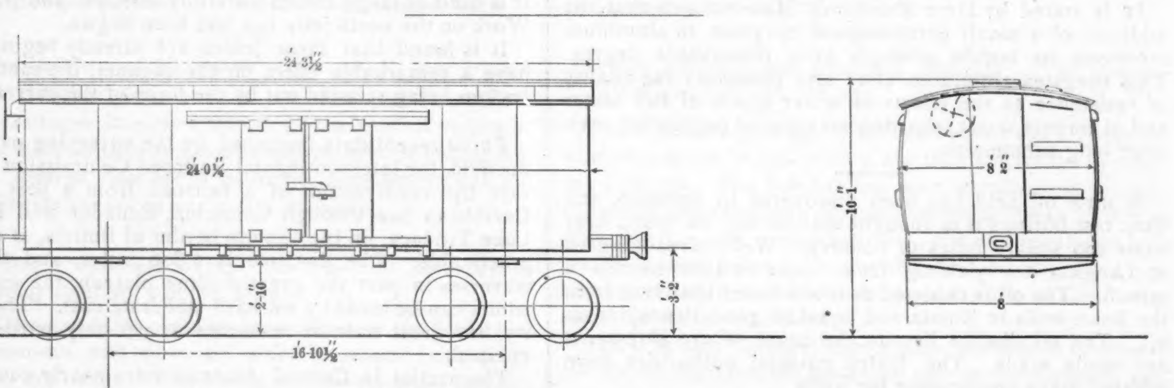
THE Rapid Transit Commission in New York has so far completed its work that the franchise for the underground lines which it laid out is advertised for sale. The sale will take place January 29, and the purchaser will have to give security for the commencement of work within a given time, and its completion within a reasonable limit. A company must be organized with $50,000,000 capital. The sale will be made to the party giving the proper security who will offer the city the best terms for the franchise,



34-FT. STOCK CAR, BALTIMORE & OHIO RAILROAD—1886.



34-FT. GONDOLA CAR, BALTIMORE & OHIO RAILROAD—1890.



IRON BOX CAR BALTIMORE & OHIO RAILROAD--1862.

THE Nicaragua Canal Convention, which met in St. Louis in June last, was called to reassemble in New Orleans, November 30. The object of the second meeting was to take measures to present to Congress the claims of the Canal for assistance and endorsement.

AT the request of a number of manufacturers, a test of the comparative strength and holding power of cut nails and of steel wire nails was begun on the testing machine at the United States Arsenal, Watertown, Mass., on November 30. The tests are conducted by a committee of manufacturers, and will include all the sizes ordinarily in use. In view of the great extent of the nail manufacture and the sharp competition now existing between the two kinds of nails, these tests are of considerable importance.

THE production of iron, which had been gradually decreasing for some months, has taken a turn and is now increasing. The *American Manufacturer's* report shows that on November 1 there were in blast 258 furnaces with a productive capacity of 173,925 tons per week; an increase in capacity of 12,367 tons during October.

The capacity of the blast furnaces at work, however, is considerably less than it was a year ago. As compared with November, 1891, the report shows a decrease of 18,818 tons, or 9.7 per cent., in the weekly output. The greatest degree of activity at present is found in Ohio and in the South.

A VERY remarkable run was made by the Empire State Express on the New York Central & Hudson River Railroad east over the Mohawk Division of that road on on November 8. The train left Syracuse 30 minutes late and arrived at Albany only 10 minutes late, having made the run of 147½ miles in 2 hours 35 minutes, including a stop of 3 minutes at Utica. It consisted, as usual, of four cars, and was drawn by Engine No. 893. The average speed, including stops, was thus 57.10 miles an hour.

The run from Syracuse tunnel to Utica station, 51.67 miles, was made in 46 minutes, or at an average speed of 67.38 miles an hour. The distance from Chittenango to Schenectady, 116.16 miles, was covered in 110 minutes, or at an average speed of 63.36 miles an hour. This is a remarkable instance of long-sustained high speed.

THE Pennsylvania Railroad has recently begun the work of doing away with one of the most troublesome grade crossings in the country—that where its tracks now cross those of the New Jersey Central at Elizabeth, N. J. To do this requires the raising of the tracks for nearly two

miles. There are four tracks, and the first work to be done is to raise two of them to the required grade on a temporary wooden trestle. When this is done, the permanent road-bed for the other two tracks will be built, and lastly the trestle first built will be replaced. Wherever possible the new road-bed will consist of earth embankment with masonry retaining walls; some of the city streets will be crossed by arch bridges of masonry and others by iron bridges. The New Jersey Central tracks will be spanned by an iron bridge.

The cost and difficulty of the work is increased by the fact that it must be done without stopping or delaying the traffic of the road. The importance of the change is shown by the fact that a recent count showed trains passing over the crossing at an average of less than three minutes' interval during the busy part of the day; and, although no serious accident has ever occurred at the crossing, it is a constant source of delay and danger to both roads.

A PECULIAR method of burning bricks is practised by the natives of Western Mongolia and the Pamir in Central Asia, which produces a brick of great hardness and not affected by the extreme changes of temperature to which those regions are subject. The great point in the process seems to be the use of a supply of water which is allowed to pass into the closed kilns, producing a volume of steam which permeates every part of the pile of bricks and seems to produce a molecular change in their structure. The bricks produced are usually somewhat larger than our customary size; they are very hard, sonorous, broken with difficulty, and present an appearance not very different from that of some of the trachytic rocks. The process seems to have some industrial value.

SOME experiments have recently been made in the electric lighting of cars on the Western Railroad of France which have thus far given encouraging results, although they have not been continued long enough to make a final decision. In these the electric current is furnished by a group of batteries of the Merrittens type—a modification of the Smee battery—carried in a box under the car floor. The lamps used are eight candle-power, and the batteries carried on each car will light it for 48 hours without renewal. As to cost, the trial so far shows a result of 1.4 cents per lamp-hour. The electric light is thus considerably more expensive than oil or gas. The experiments are to be continued.

SOME BALTIMORE & OHIO CARS.

THE drawings given with this article show three patterns of cars used on the Baltimore & Ohio Railroad, two of them being standards of the present day, while the third may be considered rather as a historical relic.

The first is the standard stock car at present in use, and its general construction is sufficiently well shown in the drawing. This car is 34 ft. long inside, 8 ft. 7 in. wide and 7 ft. 6 in. high; its outside width over all is 9 ft. 11½ in., and the frame is 36 ft. 6½ in. long over the end sills. The trucks are of the standard pattern and have 33-in. wheels. The door has a clear opening of 5 ft. and a height of 7 ft. The weight of a car of this pattern is 30,700 lbs., and its carrying capacity is rated at 40,000 lbs.

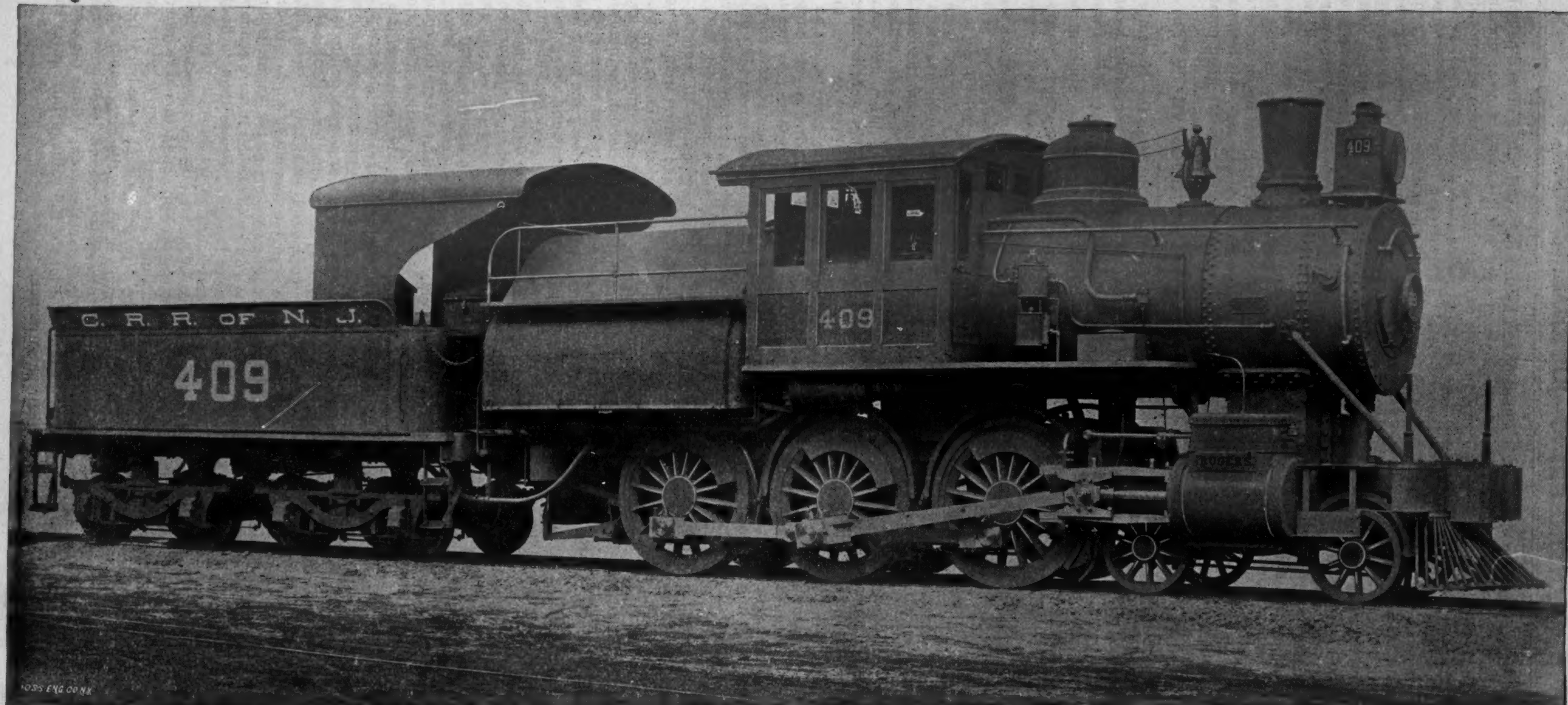
The second car is the present standard pattern of gondola, having a length of 34 ft. and a width of 7 ft. 6 in. inside the side-boards. The length over end sills is 36 ft. 6 in., and the extreme width 9 ft. 0½ in. The ordinary siding is 2 ft. 10 in. above the floor. The trucks are of the standard pattern and have 33-in. wheels. The weight of this car empty is 24,850 lbs., and it is rated at 60,000 lbs. capacity. Like the car first referred to, this is a good example of modern practice on the road.

The third illustration shows an iron box car of a type first built some 30 years ago, which was, we believe, peculiar to this road; at least we cannot recall a similar pattern on any other line. The siding and roof of this car were of iron, the only wood about it being in the floor and floor framing. Like most box cars of the same date, it was smaller than the present standard cars, having a clear inside length of 23 ft. 8 in., width 7 ft. 6 in. and height 6 ft. 1 in. The doors were small, having a clear opening 4 ft. 10½ in. wide and 5 ft. high. The sides were not straight, but wider in the center than at floor or roof, as shown in the end view. The extreme length over the drawheads was 28 ft. 7½ in., and the extreme width 8 ft. 10 in. The trucks were spaced 16 ft. 10½ in. between centers, and the wheels are 31 in. in diameter. The weight of this car was 18,000 lbs.; its capacity is not stated, but could hardly be as much as 30,000 lbs. Those who saw these cars on the Baltimore & Ohio during the war know that they seemed to stand very hard service well, but their building was not continued, for some reason not stated. It may have been their first cost, or very possibly because they were more difficult to repair after an accident than the ordinary wooden car. At any rate, this iron car is an interesting type, and certainly has some good points.

COMPOUND LOCOMOTIVE TESTS.

IN reply to some remarks made in the November number of the JOURNAL on the tests of compound locomotives on the Mexican Central Railroad, an account of which was then published, Mr. F. W. Johnstone, Superintendent of Motive Power and Machinery of that road, writes as follows:

In reply to your inquiries will say that these six bogie engines entered service during the months of September, October and November, 1890; therefore during the months from which the test was taken the engines were only a year old, and as the tubes run for four or five years on this division, and an engine remains out on the road for two years or more between overhaulings, you will see that these engines were in good condition and cannot be classed as old engines. In fact, they were in better condition than when they first entered service. On the other hand, the compound engines were more or less an experiment, and I was continually making slight changes and modifications upon them, which expense they had to bear. These bogie engines have a continuous frame carrying the boiler and tender, and the engine in working order with tank of fuel and water weighs 96 tons by actual weight on track scales. The engine has a pony truck with 17,000 lbs. on the truck. The compounds in working order, with tender loaded with fuel and water, weigh 97 tons, the engine having a four-wheel truck with 29,300 lbs. on the truck. Our experience with these compounds lead us to believe that in their present perfected condition they will continue from now on to run at less expense for repairs than the high-pressure engines doing the same work. In looking up the cause of the compound doing more work with less mileage than the bogie engines, I find that where the bogies have been obliged to double the hills, the compounds have been thrown into high pressure and have taken their trains over these hard places, and therefore have kept down their mileage in doing a given amount of work. This is an advantage decidedly in favor of the compound system. On this division where the compounds are running, we have a wooding station nine kilos from the top of the hill. Wood cars are loaded at this point, and conductors have orders to keep the side track clear of cars when loaded. If a high-pressure engine arrives at this station with a good train, and is obliged to take six or seven wood cars, they are compelled to double these nine kilos, while the compound is simply thrown into high pressure and the sand ejectors put to work. Under these conditions the hauling capacity of the engine is increased about 40 per cent., and we consider it more economical to run these nine kilos in high pressure than to double the hill. Again, nearer Mexico we have a piece of 1¼ per cent. grade three kilos long, not compensated for curvature. As this is a short hill, conductors have orders to fill out their trains along the level country before reaching the hill, and are expected to double the hill if necessary. This is another place where the compounds are thrown into high pressure, and time and locomotive mileage is saved. With these facts in view, I think the compounds should get credit for the full value of the figures shown in their performance.



TEN-WHEEL LOCOMOTIVE WITH WOOTTEN BOILER,

FOR THE CENTRAL RAILROAD OF NEW JERSEY.

BUILT BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

COLUMBIAN EXPOSITION NOTES.

THE Bureau of Hygiene and Sanitation, under the direction of Dr. F. W. Brewer, has recently issued an interesting circular, the substance of which is given below.

Starting from the standpoint that "the common health is the common wealth" and that hitherto sanitation and sanitary science have not received that amount of general public support which their importance demands, the Bureau will seek to set before the visitors to the Exposition such a representation of sanitary work and sanitary aids as will help to lift the general mind to a higher plane in its estimate of the work of sanitation. Not even the most exaggerative optimist would assert that the sanitary arrangements of our chief and best-cared-for cities are perfect, while it is well known that those of smaller towns and villages are of the most reprehensible type. On the other hand, the pessimist cannot deny that the last two decades have seen very great and very marked improvements in the theory of hygiene as a science and in its practice as an art; the "vantage ground" thus gained, it is to be hoped, will be but a new base from which a more general and complete advance all along the line may be made. That eminent sanitary pioneer, Edwin Chadwick, dared to predict that the realization of municipal and domestic sanitary reforms would eventually result in the establishment of a death-rate of five to seven per thousand in hygeian districts; thus every improvement of sanitary measures will be an aid to the fulfillment of Chadwick's vision. The often-quoted but never-to-be-forgotten results of sanitation in the city of Munich is an apt illustration of the benefits derivable. When that city was devoid of sewerage and pure water supply the death-rate from typhoid fever—pre-eminently a disease reveling in filth—was 24.20 per ten thousand. The illustrious scientist, Pettenkofer, was consulted, and recommended the establishment of a system of sewerage and the introduction of a water supply from a new source. Upon the inauguration of the new systems the death-rate was reduced to 13.30 per ten thousand; partial progress further reduced it to 9.26 and the completion of the cloacinæ caused the rate finally to fall to 1.75 per ten thousand, at which it has approximately remained.

While much in front of most other countries, the United States, with a death-rate to-day of 18 per thousand, has an arduous advance to make, but it is confidently anticipated that among the many brilliant achievements of the World's Columbian Exposition that of advancing the work of sanitary reforms will not be the least.

The United States has been the pioneer, and is still the leader in so many departments of the world's progress that it can scarcely be too enthusiastic to hope that she may rapidly forge to the front and assert her claim to be the leader in sanitation. Nowhere on the world's face are the enormous piles of masonry so numerous as they are in America; nowhere on the world's face ought the care of public life and health to be so great.

The aim of the Bureau of Hygiene and Sanitation will be to show as adequatly as possible the position in which the theory and practice of hygiene stand at the present day, and it is hoped that the universities and colleges, the boards of health, State and municipal, the societies having hygiene and sanitation as their keynotes, the scientists, the physicians, the manufacturers and the public generally will cordially co-operate in the endeavor to make the exhibition worthy of the science and of our country.

Such varied sources will naturally produce varied results. Varied results shown in diverse ways will serve to heighten the general interest in the one theme. The theme has but one end in view, the improvement of the "common health."

The general classification of this division is as follows: Class 825, Athletic and Physical Training; Class 826, Alimentation; Class 827, Dwellings, Factories, Public Buildings; Class 828, Hotels and Lodging-houses; Class 829, Public Baths, Lavatories, Closets; Class 830, Hygiene of the Workshop and Factory; Class 833, Protective Supervision.

The Bureau will arrange as far as possible for the presentation by exhibitors of models of sanitarily built and equipped dwelling-houses, urban and rural; farm-houses; school-houses; public lavatories, closets and urinals; crematories for the dead; crematories for garbage, etc. If any of those subjects should be left unrepresented by exhibitors, the Bureau will endeavor to supply the deficiency by placing adequate illustrations in the shape of models and designs before the visitors to the Exposition.

It will also exhibit scientifically arranged laboratories for the prosecution of bacteriological research, and of hygienic analytical investigations.

It will seek to supplement the valuable labors of the boards of health and of sanitary societies by codifying and collectively tabulating the results of their work.

Food and food adulterations will receive special attention, and it is desired that a complete illustration of those important subjects may be obtained.

The great problems of potable water supply, drainage and sewerage, ventilation and heating will all be duly cared for, and it is hoped that municipalities, companies and associations, as well as individual exhibitors engaged in those departments of sanitation, will aid in the efficacy and interest of the division by displaying models and illustrations of their work.

The Bureau asks the co-operation of State and local boards of health, associations and societies in making the exhibit as complete as possible, and also in collecting a library representing the latest phases of the subject.

A HEAVY TEN-WHEEL LOCOMOTIVE.

THE large engraving on the opposite page is from a photograph of one of a number of engines built by the Rogers Locomotive Works, in Paterson, N. J., for the Central Railroad of New Jersey, and now in service on that road. These engines are of the largest class, and are adapted for working very heavy trains. They are, as shown, of the ten-wheel type, having six driving-wheels and a four-wheel truck.

The boiler is of the Wootten pattern, and is of steel, $\frac{9}{16}$-in. plates being used for the outside shell. The barrel is 66 in. in diameter, and has 258 tubes 2 in. in diameter and 10 ft. 10 in. long. The fire-box is of steel, and is 9 ft. 6 in. long inside, 8 ft. $0\frac{5}{8}$ in. wide and 4 ft. $1\frac{3}{4}$ in. deep; the combustion chamber is 4 ft. $1\frac{3}{4}$ in. long. The grate area is 76 sq. ft.; the heating surface is: Fire-box, 146; combustion chamber, 63; tubes, 1,451; total, 1,660 sq. ft.

The cylinders are 21 in. in diameter and 26 in. stroke. The steam-ports are $1\frac{1}{2} \times 20$ in., and the exhaust-ports $3\frac{1}{4} \times 20$ in., the bridges being $1\frac{1}{4}$ in. The valves are of the Richardson balanced pattern, and have $\frac{7}{8}$ in. outside lap and no inside lap. The maximum travel is $5\frac{1}{2}$ in. and the lead is 0.1 in. in full gear.

The driving-wheel-base is 12 ft. and the total wheel-base 22 ft. 11 in. The driving-wheels are 63 in. in diameter. The tires are 3 in. thick, those of the main and rear pair being flanged and $5\frac{3}{4}$ in. wide; those of the forward pair are plain and are $6\frac{1}{2}$ in. wide. The driving-axles are of hammered iron, and have journals 8 in. in diameter and $10\frac{1}{2}$ in. long.

The four-wheeled truck is of the rigid-center pattern. The axles are of iron with journals 5 in. in diameter and 10 in. long. The truck wheels are 33 in. in diameter, and are solid steel spoke wheels made by the American Steel Wheel Company.

The engine is fitted with the Westinghouse automatic air brake on the tender and the American Brake Come pany's outside equalized brake on the drivers. There are two No. 10 standard Metropolitan injectors with Nathan checks and starting valves. Metallic packing is used on the piston-rods and valve-stems.

The total weight of this engine in working order is 146,500 lbs., of which 31,000 lbs. are carried on the truck and 115,500 lbs. on the drivers; an average of 19,250 lbs. per wheel.

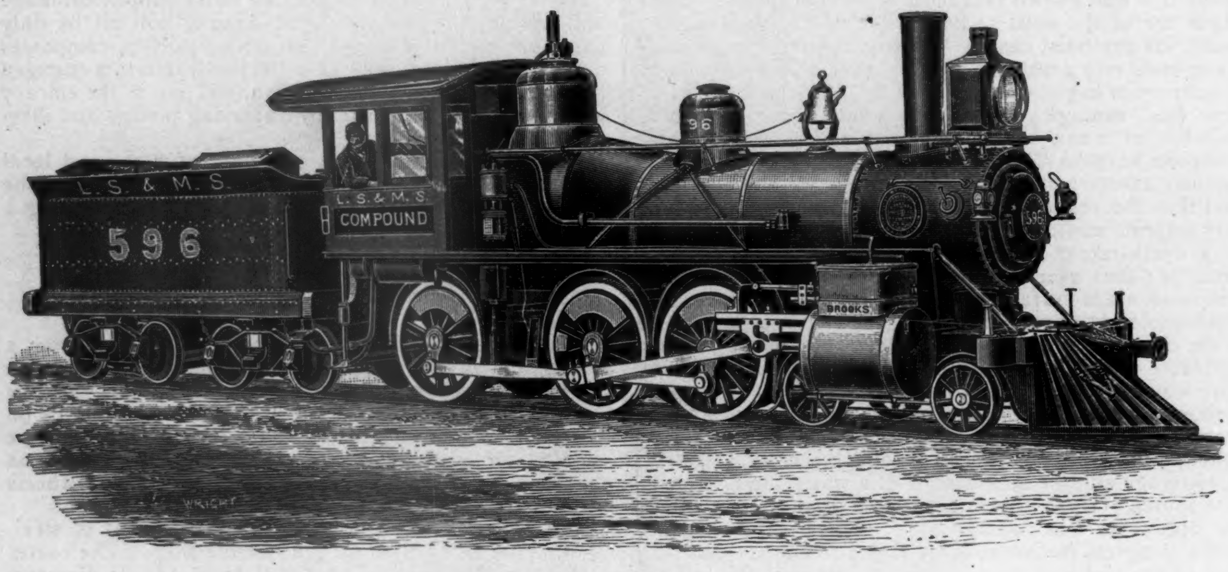
The tender frame is of 9-in. channel iron. The tank is of steel and will hold 3,600 galls. of water. The tender is carried on two four-wheel trucks. The axles are of hammered iron, and have journals 5 in. in diameter and 8 in. long. The wheels are 33 in. in diameter, and are of the

double-plate solid steel pattern made by the American Steel Wheel Company.

The general design of the locomotive and many of the details are well shown by the photograph.

A COMPOUND FREIGHT LOCOMOTIVE.

THE engraving given herewith is from a photograph of a compound locomotive built by the Brooks Locomotive Works, at Dunkirk, N. Y., and now in service on the Lake Shore & Michigan Southern Railroad. It is a ten-wheel engine built for freight service, and is of the two-cylinder compound type. The general design is shown by the photograph.



TWO-CYLINDER COMPOUND LOCOMOTIVE.

BUILT BY THE BROOKS LOCOMOTIVE WORKS, DUNKIRK, N. Y.

To give first a general description, the boiler is of the wagon-top type, built for a working pressure of 180 lbs., the material used being steel. The plates are $\frac{7}{16}$ in., $\frac{1}{2}$ in. and $\frac{9}{16}$ in.; the horizontal seams have lap joints and are quadruple riveted, and the circumferential seams are double riveted. The barrel is 52 in. in diameter, and there are 186 tubes 2 in. in diameter and 12 ft. long. The fire-box is 34 in. wide inside and 8 ft. long; the crown-sheet is supported by crown bars $5 \times \frac{3}{4}$ in. in section, and welded together at the ends. Feed-water is supplied by two No. 8 Monitor injectors. The water-space around the fire-box is 4 in. in front, 3 in. at the sides and back.

The driving-wheels are 56 in. in diameter, and the driving-axles have 7×8-in. journals. The main crank-pins are $4\frac{1}{2} \times 6$ in.; the intermediate coupling-rod pins are $5\frac{1}{4} \times 4\frac{1}{4}$ in., and the front and back pins $3\frac{3}{4} \times 3\frac{1}{2}$ in. The truck wheels are 28 in. in diameter and the truck axles have $4\frac{3}{4} \times 10$-in. journals. The rigid wheel-base is 8 ft.; the driving-wheel-base is 13 ft. 3 in., and the total wheel-base is 23 ft. 3 in.

The high-pressure cylinder is 17 in. in diameter and 24 in. stroke. The steam-ports are $16 \times 1\frac{5}{8}$ in. and the exhaust-ports 16×3 in., the width of bridges being $1\frac{1}{4}$ in. The valve has $\frac{7}{8}$ in. outside lap, $\frac{1}{16}$ in. inside clearance, and a maximum travel of $5\frac{3}{4}$ in. The lead in full gear is $\frac{1}{32}$ in.

The low-pressure cylinder is $28\frac{1}{2}$ in. in diameter and 24 in. stroke. The steam-ports are $20 \times 2\frac{1}{2}$ in. and the exhaust ports 20×5 in. The valve has $\frac{1}{16}$ in. outside lap, $\frac{1}{4}$ in. inside clearance, and its maximum travel is 7 in. The lead in full gear is $\frac{1}{8}$ in.

The slide-valves are of the Morse balanced pattern. The United States metallic packing is used for the valve-stems.

The exhaust nozzle is single and is $4\frac{1}{2}$ in. in diameter. The smoke-stack is $13\frac{1}{2}$ in. inside diameter.

The especial feature of this engine as a compound is the use of two cylinders, the intermediate receiver and the intercepting valve. The ratio of the high to the low-pressure cylinder is 1 : 2.81; of the high-pressure cylinder to the receiver 1 : 4.5. The diameter of the intercepting valve is 7 in., and the smallest diameter of the reducing valve is 3 in.; the pipe supplying live steam to the reducing valve is $2\frac{1}{4}$ in.

The reducing valve, the most important feature, is Player's patent. This is shown in detail in figs. 18–27, which are taken from the patent drawings. In these figs. 18 and 19 show a section and plan of one arrangement of the valve; figs. 20 and 21 show another form; figs. 22, 23 and 24 show the valve in various positions; figs. 25, 26 and 27 show modified forms. The construction is shown by the drawings, and can, perhaps, best be explained by quoting the inventor's own description, as below:

This valve is intended for locomotives of the two-cylinder type with an intermediate receiver, but it is applicable also to a four-cylinder engine. The valve may be placed in the cylinder saddle, as shown in figs. 20 and 21, or in the receiver-pipe, as shown in figs. 18 and 19.

When the engine comes to a rest after running with the throttle shut, the intercepting-valve, unless provided with springs, will be found open and seated against the pressure-regulating valve, the pressure-regulating valve also being closed; but if the intercepting-valve is provided with springs it will be found closed against its seat and the pressure-regulating valve will be open. In practice, however, it has been found that these springs are unnecessary, and in order to secure a more sensitive action of the pressure-regulating valve the cut-off plunger *I* is provided, working within the chamber of the valve *G*. This keeps the pressure-regulating valve in a more accurate state of equilibrium during the admission of steam. When the throttle-valve is opened, live steam is admitted to the high-pressure steam-chest through the steam-pipe *K* and passages *K'*, and operates upon the high-pressure piston in the ordinary manner. At the same time steam is admitted to the high-pressure end of the pressure-regulating valve through the connecting-pipe *J*, causing the valve to open and, passing through the slots, thence through the hollow portion of the valve, causes the intercepting-valve to close against its seat, as shown. This steam flows through the passages in the intercepting-valve into the low-pressure steam-chest, and, acting upon the large end of the pressure-regulating valve, causes it to partially close as soon as the requisite pressure is obtained

and thereafter regulates the amount of steam admitted by the pressure-regulating valve, maintaining an even pressure. The reduced-pressure steam thus admitted acts upon the low-pressure piston in the ordinary manner. As soon, however, as the high-pressure cylinder has exhausted sufficient steam into the piston, until such time as the high-pressure end of the receiver becomes charged with exhaust steam from the high-pressure cylinder at approximately the same pressure, whereupon the intercepting-valve, acting in combination with the pressure-regulating valve, permanently cuts off any further supply of

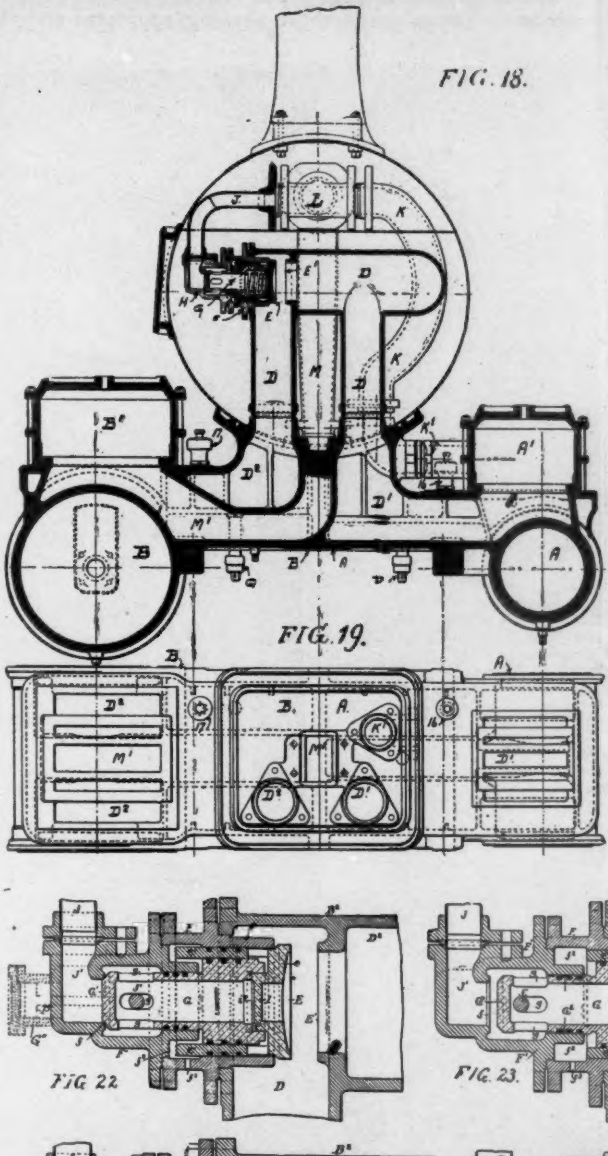


FIG. 18.

FIG. 19.

COMBINED INTERCEPTING AND REDUCING VALVE.

J. PLAYER

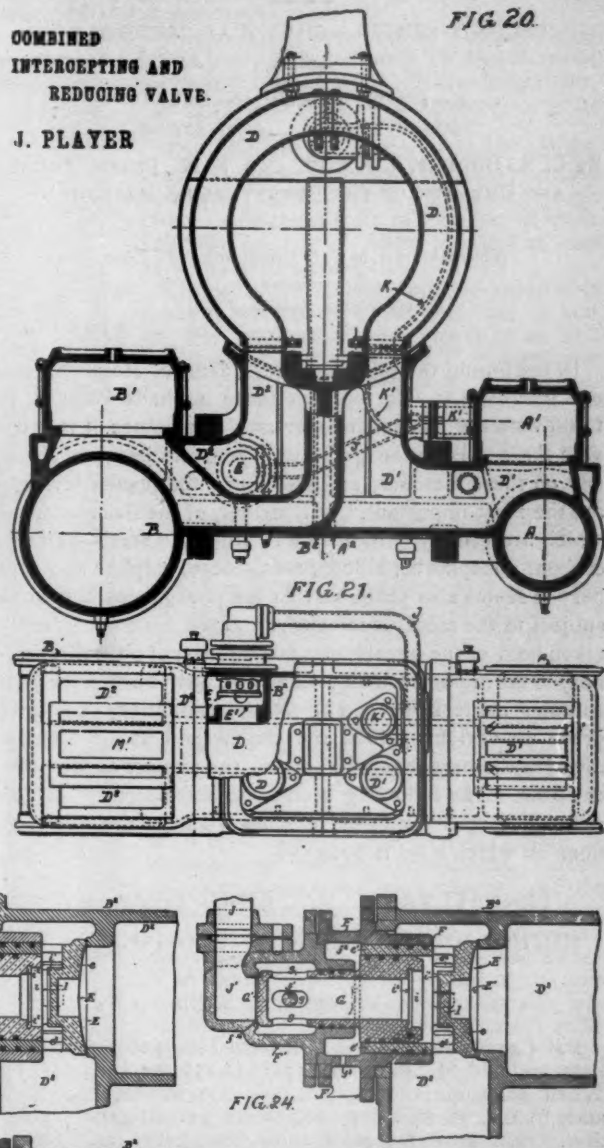


FIG. 20.

FIG. 21.

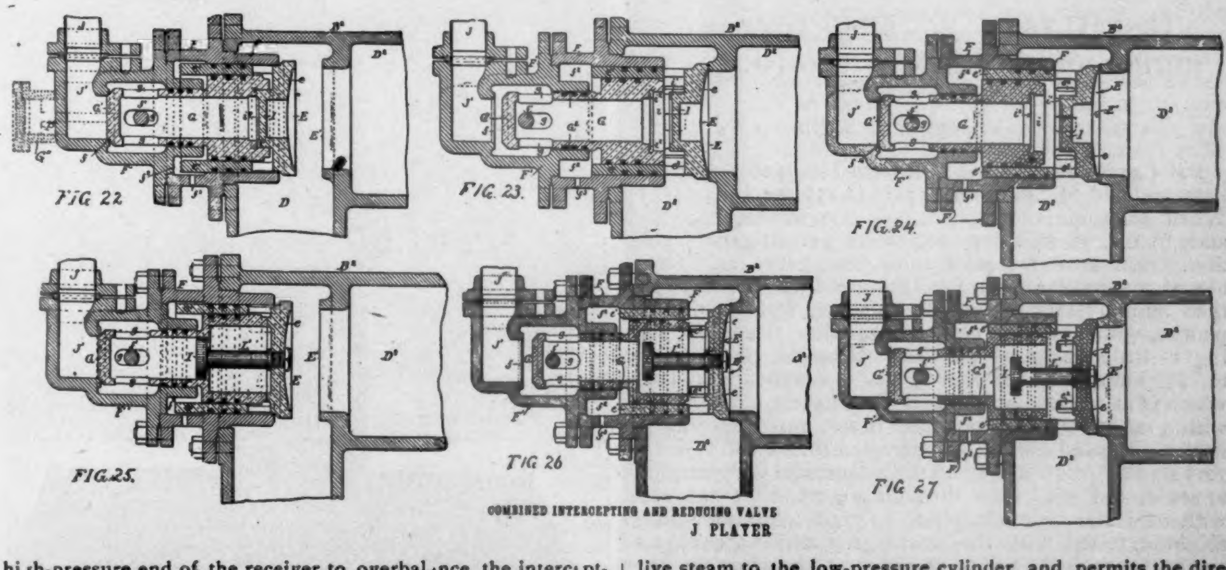


FIG. 22. FIG. 23. FIG. 24. FIG. 25. FIG. 26. FIG. 27.

COMBINED INTERCEPTING AND REDUCING VALVE
J. PLAYER

high-pressure end of the receiver to overbalance the intercepting-valve this valve opens automatically, at the same time locking the pressure-regulating valve against its seat. The exhaust steam from the high-pressure cylinder flows through the receiver and acts directly upon the low-pressure piston, the pressure of this exhaust steam, even when considerably reduced, being sufficient to keep the pressure-regulating valve closed through the action of the duplex valve at all times. It will thus be readily seen that with this improved combination live steam at a suitable working pressure is permitted to a t upon the low-pressure piston at all times in starting, and that steam at this pressure is maintained in the low-pressure side of the receiver and prevented from working against the high-pressure live steam to the low-pressure cylinder, and permits the direct passage of the exhaust steam from the high-pressure into the low-pressure cylinder. This combination also prevents the passage of live steam admitted through the pressure-regulating valve from passing into the high-pressure end of the receiver, and thus acting upon the back of the high-pressure piston.

The engine weighs, in working order, 102,000 lbs., of which 75,000 lbs. are carried on the drivers. It has been in service nearly a year, with results so satisfactory that the Lake Shore & Michigan Southern Company has recently ordered several engines now being built by the Brooks Works to be compounded in the same manner.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.*

I.—PHOSPHORUS IN STEEL.

By C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(*Continued from page* 400.)

IN beginning the publication of Chemical Methods, it is our intention to take up first those methods which have to do with the analysis of iron and steel, since it is probable there will be the greatest differences between chemists on these methods, and also since the results involved are the most important. Still further, of the six substances which are usually determined in iron and steel—namely, carbon, phosphorus, silicon, manganese, sulphur and copper—it seems also probable that the phosphorus is the one subject to the most uncertainty, and we have accordingly taken hold of the phosphorus method first of all. Preliminary to the method which follows, we have during the past summer made some 200 or 300 determinations, trying to prove up various points, and the method as given below involves the best that we know on the subject at the present time. The following is the method which, it will be remembered, is designed to make a part of the specifications on which steel is bought:

PENNSYLVANIA RAILROAD COMPANY.

METHOD OF DETERMINING PHOSPHORUS IN STEELS.

OPERATION.

Put 1 gram of the steel in a 10 to 12-ounce Erlenmeyer flask and add 75 c.c. of nitric acid (1.135 specific gravity). When solution is complete, boil one minute and then add 10 c.c. of oxidizing potassium permanganate solution. Boil until the pink color disappears and binoxide of manganese separates, remove from the heat and then add crystals of ferrous sulphate, free from phosphorus, with agitation until the solution clears up, adding as little excess as possible. Heat the clear solution to 185° Fahrenheit and add 75 c.c. of molybdate solution, which is at a temperature of 80° Fahrenheit, close the flask with a rubber stopper and shake five minutes, keeping the flask so enclosed during the operation that it will lose heat very slowly. Allow it to stand five minutes for the precipitate to settle, and then filter through a 9-cm. filter and wash with acid ammonium sulphate solution, until ammonium sulphide, tested with the washings, shows no change of color. Dissolve the yellow phospho-molybdate on the filter in 5 c.c. of ammonia (0.90 specific gravity) mixed with 25 c.c. of water, allowing the solution to run back into the same flask and thus dissolve any yellow precipitate adhering to it. Wash until the washings and filtrate amount to 150 c.c., then add 10 c.c. strong C. P. sulphuric acid and dilute to 200 c.c. Now pass the liquid through a Jones reductor or its equivalent, wash and dilute to 400 c.c. and then titrate in the reductor flask with potassium permanganate solution.

* The first series of these articles was published in THE RAILROAD AND ENGINEERING JOURNAL, December, 1889–June, 1892. The present article is the second of a new series.

APPARATUS AND REAGENTS.

The apparatus required by this method needs no especial comment, except perhaps the shaking apparatus and the

REDUCTOR FOR STEEL TESTS.

modification of the Jones reductor. The accompanying cuts illustrate these two. The shaking apparatus, as will be observed, is a modification of an ordinary milk-shake machine, and is arranged to shake four flasks at a time, which is about all one operator can manipulate, without the solutions becoming too cold. The cut is about one-

sixth the actual size of the apparatus. The flasks containing the solutions rest on a sheet of india-rubber about ¼ in. thick and are held in position by the coiled springs as shown. There is a recess in the spring arrangement to receive the cork of the flask. In the absence of a shaking apparatus the flasks may be wrapped in a towel and shaken by hand. Of course during use the door of the box is closed, the cut showing it open so that the interior may be seen. The modified reductor seems to work equally as well as the more elaborate apparatus. The cut is about one-fourth actual size. As will be seen the tube is fitted with two rubber corks, the top one of which holds the funnel and the bottom one a small tube which also fits into the rubber cork in the flask. Next to the bottom cork in the tube is a disk of perforated platinum; then about ¾ in. of clean white sand; then another perforated platinum disk, and then the tube is nearly filled with powdered zinc. At least half the zinc may be used out before it is necessary to refill.

SHAKING APPARATUS FOR STEEL TESTS.

Burettes can usually be obtained in the market which are sufficiently well made and graduated with sufficient care, so that their error can be ignored. Of course this point should not be overlooked.

The specific gravities of the reagents given are essential and the temperature at which the figures are correct is 59° Fahrenheit. In determining these gravities it is best to use a Westphal balance, but failing this a sufficiently delicate hydrometer can be used.

The oxidizing permanganate of potash solution is made as follows: To two liters of water add 25 grams of C. P. crystallized permanganate of potash, and allow to settle before using. Keep in the dark.

The molybdate solution is made as follows: Dissolve 100 grams of molybdic acid in 400 c.c. of ammonia (sp. gr. 0.96) and filter. Add the filtrate to 1000 c.c. of nitric acid (sp. gr. 1.20). Allow to stand at least 24 hours before using.

The acid ammonium sulphate solution is made as follows: To one-half liter of water, add 27½ c.c. of ammonia (0.96 sp. gr.) and then add 24 c.c. strong C. P. sulphuric acid, and make up to one liter.

The permanganate of potash solution for titration is made as follows: To one liter of water add two grams of crystallized permanganate of potash, and allow to stand in the dark not less than a week before using. Determine the value of this solution in terms of metallic iron. For this purpose 150 to 200 mg. of iron wire or mild steel are dissolved in dilute sulphuric acid (10 c.c. of strong C. P. acid to 40 c.c. of water) in a long-necked flask. After solution is complete, boil 5 to 10 minutes, then dilute to 150 c.c., pass the liquid through the reductor, and wash, making the volume up to 200 c.c. Now titrate with the permanganate solution. It is of course essential that the amount of iron in the wire or soft steel should be known. The standard in use in the Pennsylvania Railroad laboratory is a mild steel in which the iron is known by determining carbon, phosphorus, silicon, sulphur, manganese and copper, and deducting the sum of these from 100 per cent. Not less than two independent determinations should be made, and three are better. The figures showing the value of the permanganate solution in terms of metallic iron should agree to one-hundredth of a milligram in the different determinations. A very satisfactory method of making and keeping permanganate of potash solution is as follows: Have a large glass bottle holding say 8 liters and 2 of half the size. Paint the outside of these bottles with several coats of black paint or varnish. Fill the large bottle with the standard solution, and after it has stood a proper time, fill one of the smaller bottles from it without shaking and standardize. At the same time fill the second small bottle, and refill the large one. When the first small bottle is exhausted standardize the second one and fill the first from the stock. When this is exhausted standardize the first again and fill the second from stock, refilling again the stock bottle and so on. By this means a constant supply of sufficiently matured permanganate is always available. Of course if the consumption is very large, larger bottles or more of them may be required. Since changes of temperature affect the volume of all solutions, it is desirable that the permanganate solution should be used at the same temperature at which it was standardized. With the strength of solutions above recommended if the permanganate is used at a temperature of 20° Fahrenheit different from that at which it was standardized, the error amounts to less than 0.001 per cent. on a steel containing 0.10 per cent. of phosphorus.

CALCULATIONS.

An example of all the calculations is given herewith. The soft steel employed in standardizing permanganate of potash solution in the Pennsylvania Railroad laboratory contains 99.27 per cent. metallic iron; 0.1498 gram of this contains therefore (0.1498 × 0.9927) 0.1487064 gram of metallic iron. This requires 42.99 c.c. permanganate solution, or one c.c. of permanganate solution is equal to (0.1487064 ÷ 42.9) 0.003466 metallic iron. But the same amount of permanganate solution used up in producing the characteristic reaction in this amount of metallic iron will be used up in reaction with 90.76 per cent. of the same amount of molybdic acid. Hence one c.c. of permanganate solution is equivalent to (0.003466 × 0.9076) 0.003145 gram of molybdic acid. But in the yellow precipitate obtained as above described, the phosphorus is 1.90 per cent. of the molybdic acid. Hence one c.c. of permanganate solution is equivalent to (0.003145 × 0.0190) 0.0000597 gram of phosphorus. If therefore, in any sample of steel tested as above, the yellow precipitate requires 8.6 c.c. of permanganate, the amount of phosphorus in that steel is (0.0000597 × 8.6) 0.051 per cent.

NOTES AND PRECAUTIONS.

It will be observed that the method given above oxidizes the phosphorus in the iron by means of nitric acid, completes and perfects this oxidation and possibly neutralizes the effect of the carbon present by means of permanganate of potash, and then separates the phosphoric acid from the iron by means of molybdic acid. The molybdic acid in the yellow phospho-molybdate is subsequently determined by means of permanganate of potash, the phosphorus being determined from its relation to the molybdic acid in this precipitate. The method given above applies to steel and wrought iron, but is not yet recommended for pig iron.

It is hardly necessary to say that all the chemicals and materials used in the analysis are assumed to be free from impurities that will injuriously affect the result.

The 1.135 specific gravity nitric acid apparently oxidizes the phosphorus just as successfully as a stronger one, while by its use solution is sufficiently rapid, and there is less trouble during the subsequent filtration due to silica.

If the solution is boiled one minute after solution is complete it will use up much less permanganate than if the preliminary boiling is omitted.

Care should be taken to secure a crystallized ferrous sulphate free from phosphorus. The commercial salt is apt to be contaminated. It should be added in small crumbs so as to avoid excess. If too much has been used a few drops of permanganate can be added to oxidize it.

The temperature at which the molybdate solution is added to the iron solution and the resulting temperature have an influence on the result. The directions should be closely followed, a good thermometer being used to determine temperatures. Never add the molybdate solution and then heat.

In washing the yellow precipitate it shows some disposition to crawl up to the top of the filter. Care should be taken therefore to have the filter fit the funnel so closely that even if the precipitate does crawl over the top it will not be lost while washing the filter completely to the top. It is very easy to leave enough molybdic acid in the top of the filter, even though the washings are tested, to cause an error of 0.005 per cent. in the determination.

The amount of molybdate solution given above is enough to convert all the iron into molybdate, and still leave enough to carry down the phosphorus.

It is best to make up molybdate solution frequently, as it slowly changes on standing. We think it unadvisable to use a molybdate solution over 10 days old. It is best to keep the molybdate solution in the dark at a temperature not above 80° to 85° Fahrenheit. The solution should always be filtered before using. Much of the so-called molybdic acid of the market is molybdate of ammonium or molybdate of some other alkali. This fact cannot be ignored in making up the molybdate solution. A series of experiments with various molybdic acids and alkaline molybdates obtained in the market indicates that if the amount of molybdic acid in the solution is that called for by the formula, irrespective of whether this amount is furnished by pure molybdic acid or any of the commercial molybdates referred to, the result will be much nearer the truth than if this is not done. Good molybdic acid is best, but the alkaline molybdates can be used. The amount of molybdic acid in these molybdates can readily be determined by dissolving 0.1000 gram in 100 c.c. of water to which a little ammonia has been added and filter. Now add 10 c.c strong C. P. sulphuric acid, dilute to 200 c.c. and pass through the reductor. Wash and dilute to 400 c.c. and titrate with permanganate. The method given in the calculation above enables the amount of molybdic acid to be determined.

It is not advisable to make up the acid sulphate of ammonium solution for washing the yellow precipitate by using sulphate of ammonium and sulphuric acid, as the commercial sulphate of ammonium frequently contains phosphorus in some form.

The description and measurements given along with the cut of the modified reductor above will perhaps enable any one to make a suitable apparatus for themselves if they desire. The powdered zinc used is that which will pass through a 20-mesh sieve, and not pass through a 30-mesh sieve. It may be obtained from Baker & Adamson, Easton, Pa. It is essential before using the reductor to pass two or three blanks through, containing all the materials except the substance being analyzed, and then titrate these blanks. The last two blanks should agree exactly, and the amount of permanganate used up by the last blank should be deducted from the final figure obtained on titration of the substance being analyzed. This preliminary preparation of the reductor is essential after a new charging with powdered zinc, and also equally essential after the reductor has stood idle even over night. The rate at which the material passes through the reductor can be controlled somewhat by the suction. The apparatus is very efficient, and there seems little danger of too rapid a rate, but it is of course essential that the reduction should be complete. The properly reduced yellow precipitate solution should be green or slightly so, depending on the amount of molybdic acid present. A trace of "port wine" color in the reduced solution before titration with the permanganate indicates lack of complete reduction and renders the result of the analysis doubtful. In case of incomplete reduction pass the liquid through the reductor again. If the rate is somewhat slow and the solution being reduced somewhat warm, hydrogen gas enough may be generated to throw some of the liquid up against the sides of the tube above the zinc, and also bubble up through the liquid in the funnel. Care should be taken that this latter does not result in loss, and that the liquid adhering to the sides of the tube is removed by the subsequent washing.

There is some analytical evidence when using the method described above, that a portion at least of the arsenic which may be present in a sample of steel under examination is precipitated along with the phosphorus, and counts as such in the final result. Until some simpler method of overcoming this difficulty than any at present known has been devised, and until the injurious effect of arsenic on steel has been demonstrated to be so small that arsenic can safely be ignored, the results obtained by the above method will be regarded as the phosphorus content of the various steels purchased in accordance with Pennsylvania Railroad specifications.

Samples of steel in which the phosphorus has been determined will be sent to parties asking for the same in order to enable them to make such comparisons as they may desire.

In formulating the method given above, the published work of Emerton, Wood, Drown, Hundeshagen, Colby, Shimer, Handy and Jones has been freely consulted and used. It would be difficult to state in detail what is due to each.

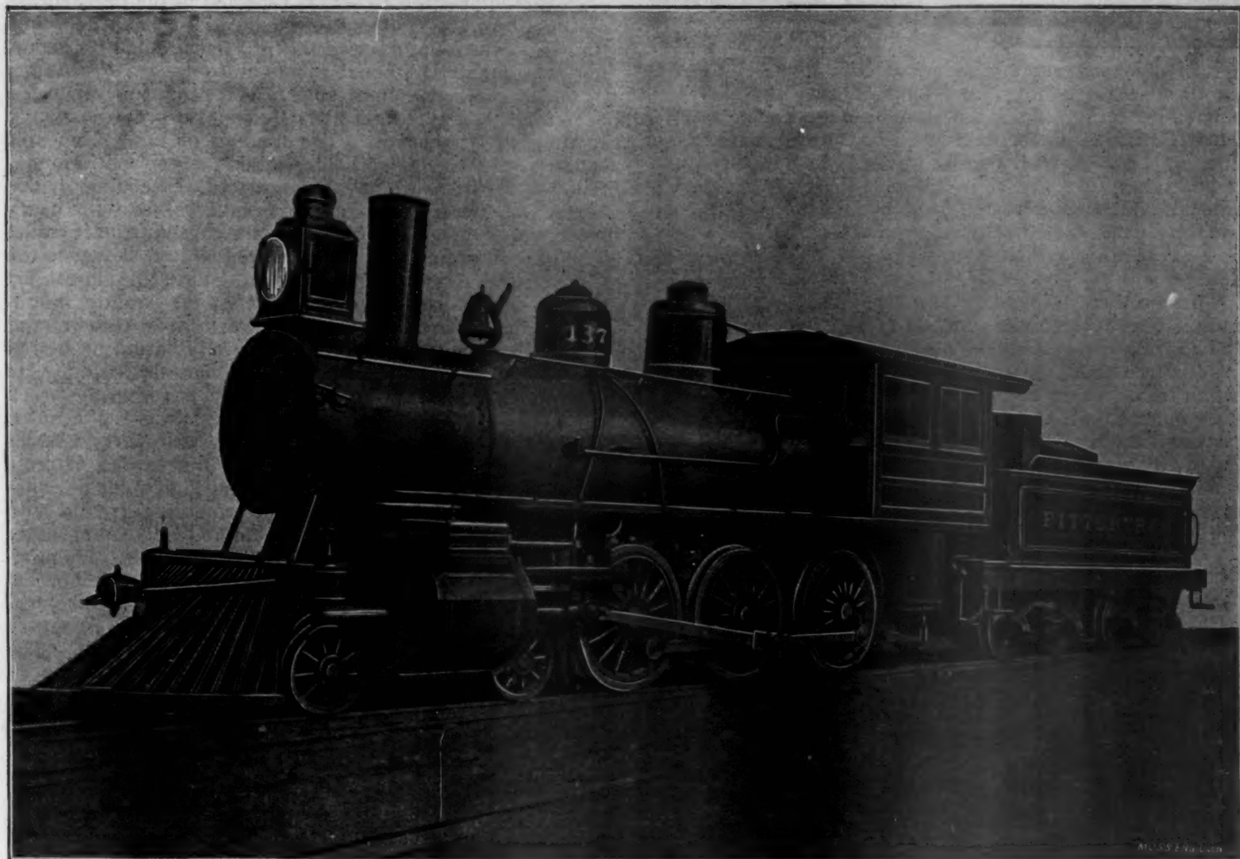
THEODORE N. ELY,
General Superintendent Motive Power.

In the January number some discussion of this method will be given, showing the reasons for adopting it.

(TO BE CONTINUED.)

A COMPOUND FREIGHT LOCOMOTIVE.

THE accompanying illustration is from a photograph of a ten-wheel compound engine recently built by the Pittsburgh Locomotive Works. It is of the two-cylinder type, and has the starting-valve patented by Mr. Henry F. Colvin, of Philadelphia. With this the engine can be worked as a compound, or steam can be admitted directly into the low-pressure cylinder at the will of the engineer. In the latter case the valve admitting steam from the boiler acts as a reducing valve, in order to equalize the force exerted in the two cylinders.



TWO-CYLINDER COMPOUND ENGINE BY THE PITTSBURGH LOCOMOTIVE WORKS.

The boiler has large heating surface and is intended to work at 180 lbs. pressure. The high-pressure cylinder is 19 × 26 in. and the low-pressure 29 × 26 in. The driving-wheels are 56 in. in diameter. The driving wheel-base is 11 ft., and the total wheel-base is 21 ft. 8 in. The total weight of the engine is 120,000 lbs., of which 95,000 lbs. are carried on the driving-wheels.

This engine has been on trial on the Pittsburgh & Western Railroad, and its performance so far has been very satisfactory. No detailed reports of tests have yet been made, but they will doubtless be furnished hereafter.

RAILROADS OF NEW SOUTH WALES.

(From the *New South Wales Railway Budget.*)

THE Fourth Annual Report of the Railway Commissioners of New South Wales was laid on the table of the House on August 30, which is within two months of the closing of the financial year.

The Railway Report attracts more attention than any other similar document submitted to Parliament. The results of the working of the railways and tramways are closely watched, not only locally but also by the British bondholders, who, to a certain extent, regard them as their security.

Briefly stated, our railways cost £33,312,608; during the past year they earned £3,107,296, and the working expenses amounted to £1,914,252, thus leaving a net profit on working of £1,193,044, equal to 3.58 per cent. interest on capital. These figures clearly indicate the extent to which the railways are used by the, comparatively speaking, limited population of the colony.

On June 30 there were 2,185 miles open for traffic, the passenger journeys reached 19,918,916, and the tonnage of goods carried 4,296,713. To convey this traffic 8,356,096 train miles were run, the earnings per train mile being 89.25*d.*, the working expenses 54.98*d.*, and net profit 34.27*d.*

During the past three years considerable improvements in the rolling stock and permanent way have been effected; the regular passenger trains now present a pleasing appearance by their uniformity, while the superior fittings in the carriages, and the improved permanent way, tend to increase the comfort of traveling.

The passenger stock numbers 1,054 vehicles, the goods stock 10,455, and the locomotives 489.

The attention given to the interlocking and the permanent way has considerably increased the safety of the railway men who have to do with the running of the trains, and the traveling public; thus, while in October, 1888, on only 28 miles of line the traffic was worked under the absolute block system, we have at present 754¼ miles worked under that system, while the number of places which have points and signals interlocked increased during the same period from 104 to 260.

The report also furnishes some interesting facts regarding the suburban passenger fares. It is rather surprising to note that, although higher rates for wages and other charges prevail in this colony, the fares are considerably lower than those in force on the principal English lines for similar distances. It may also be remarked, that our grain rates are below those of the other Australian colonies.

The effect of extending the railways into the interior,

and so developing the resources of the colony, may be seen from the following table :

	1857.	1892.
Population of the Colony	283,000	1,182,500
Miles open	40	2,185
Persons to each mile of line	7,075	540
Passengers carried	329 019	19,918,916
Journeys per head of population	1.16	16.85
Tonnage of goods	20,847	4,296,713
Tons carried per head of population	0.074	3.634

Railway construction almost ceased in 1889, and during the three years ending June 30, 1892, only 13 miles were opened for traffic, but since that date the line from Nyngan to Cobar, 81 miles, was opened. The Culcairn-Corowa line, 47½ miles, will also be opened in a few days, and, in addition, there are 203½ miles under construction, 97 miles of which are expected to be taken over from the contractor during the current year. On October 1 there will be 2,313½ miles available for traffic—2,162 single line, 143 double, and 8½ quadruple.

The number of persons employed in the railway and tramway form the large army of 11,789 men.

The tramway system has also shown improvement during the past year, the fares collected on the city and suburban trams alone amounting to 65,299,063. The cost of the whole of the lines, 48 miles, is £1,099,659. The gross earnings amounted to £305,090, the working expenses to £248,591, leaving the sum of £56,499, as the net receipts, equal to 5.28 per cent. on capital invested, being an increase of 3.30 per cent. over the year 1888.

PATENTS AT THE COLUMBIAN EXPOSITION.

THE following letter was some time ago addressed to the Inventors and Manufacturers of the United States by Hon. W. E. Simonds, Commissioner of Patents. It was published in the *Official Gazette* of the Patent Office, and certainly deserves attention. It is of interest as showing what is to be done at Chicago next year, and it is to be hoped that the desired co-operation will be generally given :

It is the intention of the Patent Office to make at the World's Columbian Exposition at Chicago in 1893 an exhibit which will show that great advance in the several arts which is due, in large measure, to the encouragement and support afforded by our patent system. This exhibit is to consist of models of patented inventions, which will be carefully selected, to show as far as is possible the inception of each art, the stages through which the art has advanced, and the final development reached at the present time. This display of typical inventions, embodied in concrete form and properly arranged, will, it is believed, constitute a grand historical exhibit of the progress of the useful arts and one which will be of great interest not only to inventors and manufacturers, but to the public generally.

The Office collection of models has been seriously impaired by fire, and is further incomplete by reason of the fact that models have not generally been required or received during the last ten years. The Office is not, therefore, in possession of the models of many valuable inventions which might properly be included in such an exhibit, and without which, indeed, the exhibit would be incomplete. The limited appropriation for this exhibit will not permit the Office to make such models. An urgent appeal is therefore made to all inventors and manufacturers to come to the assistance of the Office in this matter, either by loans of models already built or by the construction of such models not in the possession of the Office as should properly be placed in such a collection. Of course, where models are loaned to the Office all proper credit will be given both in labels and catalogues to the parties by whom the loans are made, and such disposition will be made of the models after the close of the exhibit as the owners shall direct. Many inventors and manufacturers have already indicated a willingness to co-operate with the Office in this matter, and it is confidently expected that such a response will be made to this general appeal as will assure the unparalleled success of this attempt to graphically and concretely show the development of American invention.

THE RECENT SURVEY OF ST. LOUIS.

(Condensed from paper by B. H. Colby before the Engineers' Club of St. Louis.)

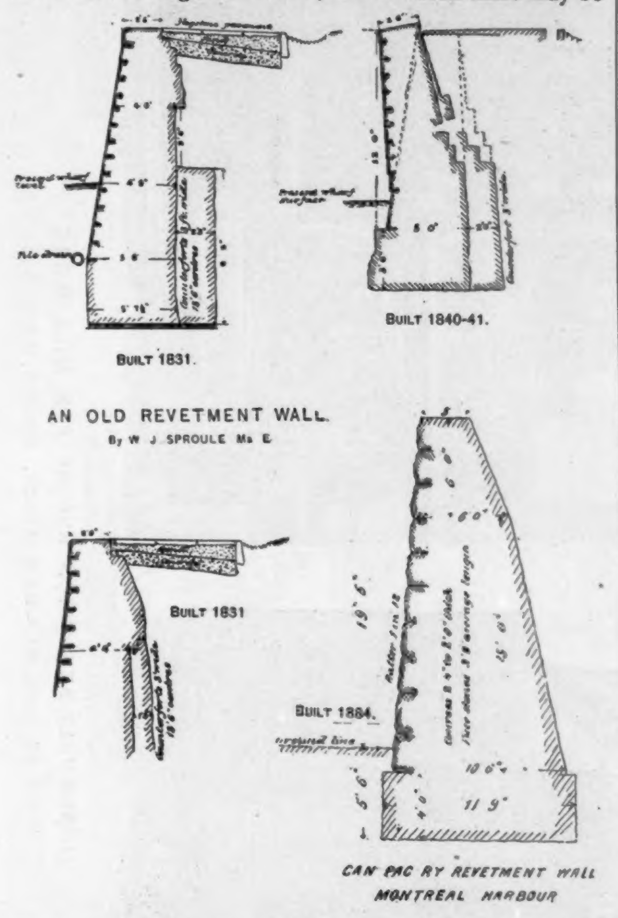
IN this interesting paper, as reported in the proceedings of the Club, Mr. Colby gave the geodetic basis on which the work was founded, and the means adopted for securing monuments and bench marks on roofs, graveyards and in the streets. He then specified the instruments used : a Gambe, a Fauth and two Buff & Berger transits, all reading to 10 seconds. The method of taking multiple readings of the angles was described on the repetition system. The area already triangulated, exceeding 27,000 acres, was described, and the number of stations occupied, which averaged two stations to the square mile. The base-line used was from the old Water Tower to the City Insane Asylum, which has a length of almost six miles. Mr. Colby recommended that the granite monument recently erected in Forest Park, near the weather station, be hereafter adopted for the city datum, in lieu of the old city directrix, which had been destroyed. He stated that the error of closure in the triangles averaged 3.7 seconds and the mean error per angle was 1.2 seconds. The general system of triangulation was to carry a series of primary triangles from the base-line to the extreme limits of the city, with an average length of sides of about two miles, and then fill in the intermediate ground with small secondary triangles. The method of keeping notes and making computations was then described. He mentioned that pole-targets, which were difficult to see on account of the smoke, and were tampered with by mischievous boys, were replaced by heliotropes or flash signals, a very simple and yet effective design being employed. The flash system gave much better closures of the triangles, as the average was 4.6 seconds with the poles, and 2.7 seconds with flash signals, or an average of both systems of 3.7. The heliotropes also permitted the Morse alphabet to be used in telegraphing from station to station. The method of carrying on precise leveling was then described, and the instruments employed were exhibited. In all 743 benches have been established, or 12 per square mile, mostly on the stone sills of the buildings, the location of which is printed every year in the annual report of the Sewer Commissioner. The average error has been 0.001 ft. per mile and the maximum permitted was 0.009 ft. per mile. If the error of closure was larger, the work was rerun. He then gave a new theory, based on studies made by Mr. E. J. Jolley, of the constant error found in precise leveling, which he explained as being due to always holding the eye-end of the level tube in carrying it, and therefore causing a local expansion of the eye-end of the tube that diminished the longer the instrument was used at a station, and hence the error was always greatest on the back sight. He stated that the topographic work was carried on with true azimuths. He gave the results of some stadia observations made after 4 P.M., which showed that the refraction error is so great as to make stadia more unreliable before 10 A.M. or after 4 P.M. ; an error of 0.2 ft. was found in 200 meters. He prefers to keep the topographic notes in the form of a few brief descriptions rather than by sketches. The methods employed in plotting were explained and a special protractor and slide rule exhibited. Mr. Colby also spoke of the different methods of graduating stadia boards, and gave some results that showed a marked tendency to error by the point system. The paper gave the results of carrying a stadia survey around the perimeter of St. Louis that covered a distance of 40.4 miles ; 306 stations were occupied, with an average length of 211 meters per station. The maximum error in azimuth was 12 ft. 3.5 in. at a distance of 34.9 miles, and the closing error was 8 ft. 2 in. The error in altitude in closing, after running the 40.4 miles, without checking on any intermediate benches, was 0.64 ft., with a maximum of 1.37 ft. at the 27th mile. The

cost of the triangulation, topography, leveling and office work, covering all expenses for 815 working days, amounted to about $35,000, at a cost of $1.15 per acre, or 14.5 cents per lot. The work was carried on by four engineers, with assistants, but only one party was in the field at a time, the others being busy in the office.

AN OLD REVETMENT WALL.

(Paper by W. J. Sproule, M.E. From the *Transactions* of the Canadian Society of Civil Engineers.)

THE old revetment wall along the city front in Montreal harbor is a very instructive example for civil engineers—more instructive than modern examples of massive masonry which show no signs of failure, and in which there may be much surplus strength, and hence much unnecessary capital buried. It is an example of a wall so nearly equal to the requirements that part of it remains in good condition, while part has failed. The accompanying cross-sections show that the wall is much lighter than the practice of the present day warrants for similar situations, as is seen by comparing its cross-section with that of the Canadian Pacific Railway revetment wall recently built, and yet, after 50 years' duty, a considerable part of the wall is but little disturbed, and with a similar rate of degeneration would not be in bad condition 50 years hence, while part has failed so badly that it became unsafe, and timber props were resorted to several years ago. Part of the wall was built in 1831 and part in 1840–41. The failure during recent years has been very gradual, and the displacement probably nearly equal from year to year. Parts of both the older and newer portions of the wall have failed. Their cross-sections differ but little. This seems to indicate that the wall of 1831 had not shown signs of failure in 1841, otherwise the newer wall would likely have been built heavier. The wall is an ordinary retaining wall to support a city street. In the rear the ground rises rapidly in part, and in part is level for a considerable distance back. The wall is about one mile long, and on the harbor side is bare for a height of about 10 ft. from the wharf level to the coping.

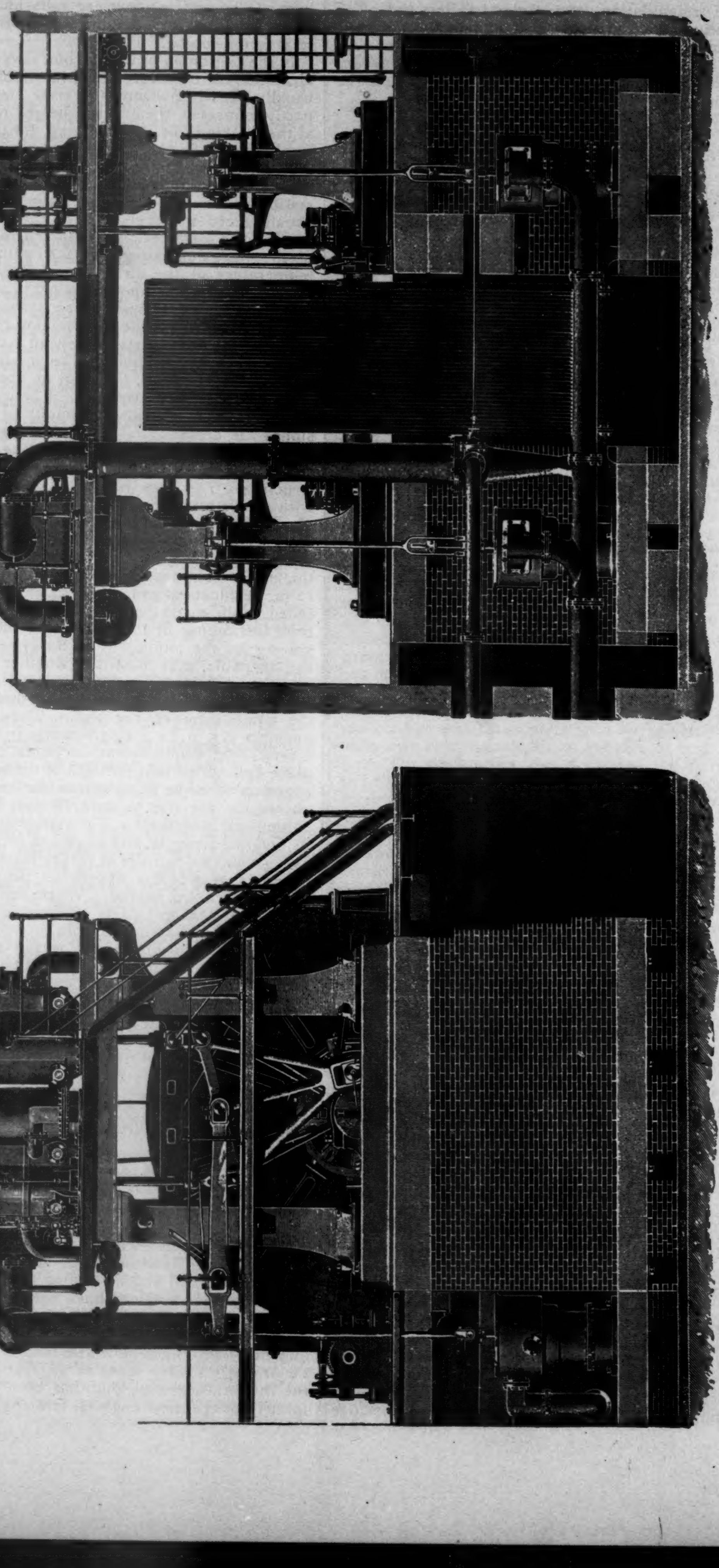


In the beginning of winter, but always after a considerable interval of severe frost, in which the thermometer usually goes below zero, the river rises until the wall is partly immersed, the average height reached by the river at the "taking" of the ice being, for the last 40 years, a level within 5 ft. of the coping of the wall, varying, however, much from this level, often being lower and frequently nearly up to the coping. After the ice becomes stationary on the river the water falls gradually, and usually recedes from the foot of the wall, but at times remains for a long period in winter 1 to 3 ft. upon the face of the wall, fluctuating 1 to 2 ft. with variations in the temperature of the air. Part of the wall in this way is often exposed to temperatures 15° to 20° below zero after being immersed in water for days or weeks. But this does not seem to be the determining cause of failure, for the best and worst parts of the wall have been equally exposed to these conditions. The masonry on the inclined surface of the ramps, however, at about 1 to 3 ft. above wharf level is much displaced. The wall is built of limestone from quarries in the vicinity of Montreal. A few stones are cracked and somewhat weathered, but sufficient disintegration has not taken place in the stones themselves to perceptibly affect the general stability of the structure. The face is bush-hammered ashlar backed with rubble masonry. The face courses vary from 10 in. to 13 in. in thickness, but are in general 11 or 12 in. thick, and the stones in certain parts average 3 ft. in length; in other parts, 3 ft. 5 in. The bed joints average 0.22 in. in thickness. The coping stones average 5 ft. 2 in. in length, 12 in. in thickness and 2 ft. 6 in. in width. The wall has failed by sliding on the joints, especially at 8 to 10 ft. down from the coping or 1 to 2 ft. above the wharf, and by revolving on the joints, but as no systematic observations are available, it is uncertain whether these two motions have taken place simultaneously, or that the revolving began after the sliding movement had seriously affected the equilibrium of the wall. The sliding movement amounts to 5 in. in a single course in certain places, and a very slight displacement on joints seems to have taken place even in the best portions of the wall, but are here so slight as to make it uncertain whether the irregularities observable are due to imperfections in the setting or to subsequent movement. The mortar seems to have lost all its bonding strength, and as picked from the joints appears as a granulated mixture of earthy materials and lime. No openings or weepers appear on the face of the wall to drain water from behind. Where excavations have been made near the best parts of the wall the foundation is a coarse sand, apparently the old river beach, and this porous material no doubt has served a useful purpose in draining the wall, but the examinations have not yet been extensive enough to warrant the conclusion that the superior condition of the wall here is wholly due to this cause. Fortunately the wall has served its purpose, and must be taken down and entirely obliterated in carrying out the general harbor improvement project lately adopted, and this would be necessary, even if the wall were in the best condition. When this is done, something more may be learned of the weak points of the wall, and of the causes that preserved or destroyed it.

A QUADRUPLE-EXPANSION ENGINE.

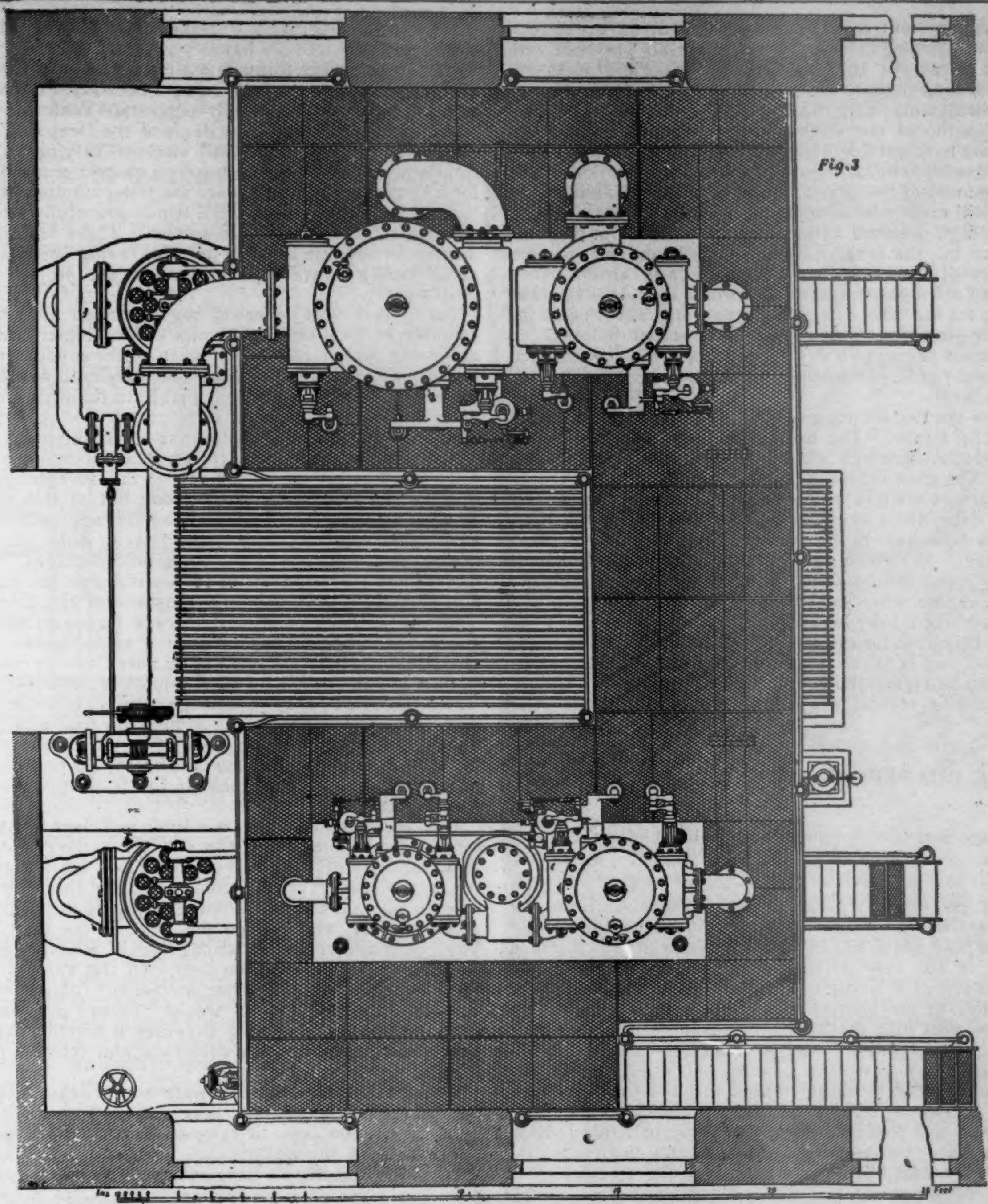
(From London *Engineering*.)

WE illustrate herewith an engine which is remarkable as being an application of the system of quadruple compounding to land engines. For four or five years quadruple-expansion engines have been fitted to steamers by several firms of marine engineers, and the economical results attained have suggested to Messrs. John Musgrave & Sons, of Bolton, England, the idea of applying this type for driving spinning machinery. Curiously enough, while the three-throw crank-shaft has been found most suitable for triple-expansion engines, few engineers have thought



QUADRUPLE-EXPANSION ENGINE FOR MILL WORK.

BUILT BY JOHN MUSGRAVE & SONS, BOLTON, ENGLAND.



QUADRUPLE-EXPANSION ENGINE FOR MILL WORK.

of using a four-throw crank with a quadruple engine. Various forms have been adopted, the two higher pressure cylinders being usually placed above the lower pressure cylinders, with two cranks. Messrs. Fleming & Ferguson, of Paisley, Scotland, have, however, adopted a unique arrangement, and the distinctive features of their design have been followed in Messrs. Musgrave's engine.

A reference to the plan given herewith will show that the cylinders are disposed in pairs on each side of the fly-wheel or rope drum, the two higher pressure cylinders being on one side and the two lower pressure cylinders on the other. The cross-heads of each pair of cylinders are connected by means of a pair of links and a triangular connecting-rod, as shown in the side elevation. The two cranks of the engine being opposite each other, the weights of the two sets of reciprocating parts balance each other. Although the cross-heads of the two cylinders are connected to one crank, they are never at the ends of their respective strokes at the same time, so that there are no dead centers to the engine. The turning effort, indeed, is the same as if the cross-heads were connected to cranks set nearly at right angles to each other. In other words, when one piston is at the end of its stroke the other is nearly in its central position and has a very effective leverage to turn the crank. Besides, the strains on the crank are gradually changed around the crank-pin from one side to the other, and never suddenly reversed, as with an ordinary engine, so that the vibration or jarring is minimized. The triangular connecting-rod vibrates on a pin in the ends of a pair of levers swinging on a fixed center outside of the frame. Extensions of the levers are made use of to work the air pumps, as shown in the engravings. The arc formed by this swinging lever, as well as the circular path of the crank pin, gives the end of the triangular rod a vibrating motion, so that the ends of the rods move vertically and thus reduce the pressure on the guides.

The engine is of the vertical inverted type, and its gen-

eral arrangement is very compact, as will be understood from the drawings. The cylinders are all provided with Corliss valves, the admission valves for the high-pressure and first intermediate being under the control of the governor, which may vary the point of cut-off from nothing to three-fourths of the stroke; the cut-off in the other two cylinders is adjustable by hand. All the admission valves are provided with Musgrave's patent trip motion. The arrangement of bed-plates, uprights and the framing generally will readily be understood from the engravings.

The high-pressure cylinder is 18 in., the first intermediate 26 in., the second intermediate 37 in. and the low-pressure 54 in. in diameter, all being 54 in. stroke. The ratios of the high-pressure to the other cylinders are thus 1 : 2.09 for the first, 1 : 4.23 for the second, and 1 : 9.00 for the low-pressure. The engine is expected to make 80 revolutions per minute in ordinary work, making the piston speed 720 ft. per minute. The working pressure will be 200 lbs.

There are two air pumps, each 26 in. diameter of bucket and 15 in. stroke. The main shaft is 16½ in. in diameter, and the bearings are 15 in. in diameter and 30 in. long. The shaft center is 19 in. in diameter. The crank-pin bearings are 9 in. in diameter and 10½ in. long.

The rope drum or driving-wheel is 21 ft. in diameter, and its face has 36 grooves, made for ropes 1⅝ in. in diameter. At 80 revolutions per minute the speed of these driving ropes will be about 5,280 ft., or a mile a minute.

This engine, when working with steam at 200 lbs. pressure and when fully loaded, is expected to develop 1,600 H.P. It is built for the Peel Spinning Company, at Bury, England, and is to run a mill containing 104,000 spindles.

It may be further noted that Messrs. Musgrave & Sons are building several engines of the same type for other mills.

THE CHESAPEAKE & DELAWARE CANAL.*

(Condensed from lecture by Professor Lewis M. Haupt before the Franklin Institute, Philadelphia.)

THE peninsula separating the Chesapeake from the Delaware extends southwardly 175 miles from the narrow neck of land which the canal traverses, while the distance across is but 13⅝ miles. Prior to the railroad era the importance of piercing this barrier and thus saving over 300 miles in the journey from Philadelphia to Baltimore by water was fully realized.

The Canal Company was incorporated in Maryland in 1799, and work was begun in 1804, but little progress was made until after the completion of the Erie Canal in 1825. Judge Benjamin Wright was then appointed Consulting Engineer, and pushed the work so vigorously that in September, 1829, barges passed through, and on October 17, 1829, it was officially opened with imposing ceremonies.

The magnitude of this undertaking at so early a date can scarcely be appreciated at the present stage of applied science. In the "Deep Cut," which is nearly 4 miles long and 76 ft. deep at its highest point, there were 3,500,000 cubic yards of earth which were removed and deposited beyond the sides of the cut, making the present height in some places 100 ft. There were difficulties from landslides and bottomless marshes, so that the excavation and fill exceeded the original amount by over 10 per cent., yet the entire work was rapidly completed at a cost of $2,250,000, or $161,000 per mile.

The general dimensions of the trunk of this original canal were the same as those of to-day: 66 ft. wide at the surface, 36 ft. at the bottom, and 10 ft. deep, while the locks were 100 ft. long and 22 ft. wide; but in 1854, or a quarter century later, they were enlarged to 220 ft. in length by 24 ft. in width, which dimensions they still retain, although much too small for the vessels of to-day.

There are two levels to surmount; the first extending from Delaware City, where there is a tidal lock of 6 ft. lift, to St. George's, 4½ miles; the second reaches from St. George's lock, with its 10 ft. lift, to Chesapeake City, about 9 miles. Here there is a single lock of 16 ft. descent into Back Creek, a tributary of Elk River, which in turn debouches into the bay.

The route passes through a rich agricultural country, and the channel is far from being a contracted ditch, such as the name canal generally suggests. With the exception of the pass through the defile of the Deep Cut, it is a succession of pools and broad streams, varying in width from a few hundred feet to nearly a quarter of a mile, and for a large part of the distance the tow-path does not conform to the sinuous banks, but winds gracefully along an embankment placed in mid-stream. These features are mentioned because they are peculiar to this line, and form exceptionally favorable conditions in the project of enlargement.

For 63 years this waterway has continued to perform a valuable service, but in the race for supremacy, and the expansion which has taken place in the capacity of vessels, it has gradually fallen to the rear, until now it may be said to be antiquated and unable to fulfill the purpose of its builders. . . .

In every engineering enterprise it is important to sit down first and count the *cost* as well as the revenue.

This has been done on the part of the Government, and it is estimated at over $7,000,000; but of this amount $3,249,664 was for dredging in the approaches, and $4,355,808 was for the canal 100 ft. wide, its locks, bridges and other works, including land damages. These dimensions are, however, unnecessarily wide for the present, especially in view of the shortness of the Deep Cut. There is no need of a double track through these four miles, and hence a smaller section would prove just as effective and much cheaper. The Suez Canal is but 72 ft. wide at bottom, and the Amsterdam 86 ft., while the Sault, which to-day outranks in tonnage any canal in the world, was only 64 ft. wide and 13 ft. deep up to the date of its enlargement, which was completed in 1882. The present dimensions are 108 ft. wide at the narrowest part, increasing to 500 just above the lock, and 16 ft. deep, the section being rectangular.

By a reduction of width to a limit sufficient to pass the largest ocean-going vessels in single file, the cost of construction may be kept within $3,000,000 for the 14-mile canal, while the revenue would be derived from the entire foreign commerce of Baltimore going to Northern and Eastern ports, which is 90 per cent. of the total, and a large local and coastwise tonnage, all of which aggregate for the two bays, 27,000,000 tons. Of this amount 20 per cent. would no doubt traverse the canal. This at the low rate of 15 cents per ton would produce a revenue of $810,000. After deducting expenses it should leave not less than 15 per cent. for dividends and interest on the capital.

As the economic value of a waterway is dependent upon the ratio of its length (and hence its cost) to the distance saved, it will be seen by comparison that there are only two canals in the world which surpass this one in this particular—they are the Suez and the proposed Nicaragua. The Suez Canal, 100 miles long, saves 3,750 miles. Its length is therefore nearly 3 per cent. of the distance saved. The Nicaragua, 169 miles long, is less than 2 per cent. of the 10,000 miles which it would save.

The Chesapeake & Delaware is but 4 per cent. of its greatest saving.

The North Sea & Baltic, 61 miles long, is 27 per cent. of distance saved.

The length of the Florida Ship Canal would equal 29 per cent. of the distance cut off, but as it would be 169 miles long and transit through it would be slow, the economy in time would be only 12 hours between New York and New Orleans.

The length of the Amsterdam Canal is 42 per cent. of the former route.

In short, it would seem that there are but few if any places on the face of the globe where so small an expenditure of capital gives promise of such large and immediate returns, where there is so large a commerce in sight in the adjacent and tributary waters, where the benefits to the overland lines of transportation will be so great and where the work will be of the utmost practical utility to the Government in increasing the efficiency of its naval

force in time of war, and a potent factor in removing cause for war with any foreign power in times of peace.

In fact its construction becomes a matter of necessity if we hope to keep pace with and aid in the symmetrical development of the commercial interests of our country as a whole.

THE BERLIN UNDERGROUND RAILROAD.

THE building of an underground electric railroad in Berlin has been for some time under discussion, and plans for its construction and the operation of the trains by electricity have been submitted by the Allgemeine Elektricitats Gesellschaft. The sketch map, fig. 5, shows in outline the roads to be built, the solid lines showing those first required. These consist of a circle or ring line, intersected by two long cross-lines with terminal loops. The latter connect with the railroads entering the city.

An outer circle, to be added later, is shown by the dotted lines.

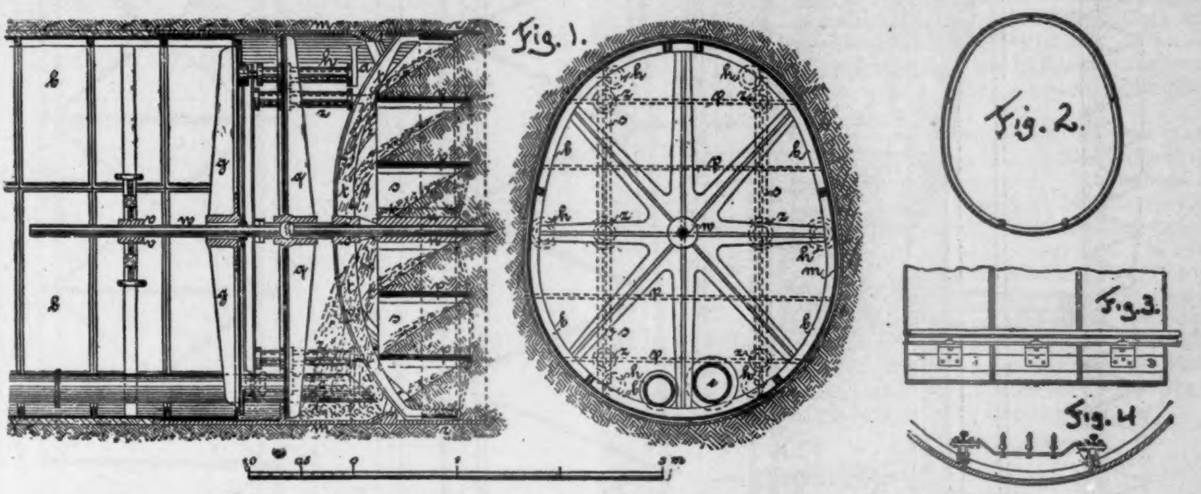
Berlin already has an outer circle or line around the city, known as the Ringbahn. This is a surface line connecting the roads entering the city, but it is too far out to serve for city travel. From Charlottenberg a cross-line extends from this road to the opposite side of the city near the Spree. The cross-line is partly a surface road, but through the built-up portion of the city it is elevated on masonry arches.* The Ringbahn and the Stadtbahn,

as the cross-line is called, are shown on the map by the heavy dotted lines. The Stadtbahn carries many passengers, but serves only a small part of the city.

The method proposed for building the tunnel is indicated in fig. 1, and is similar to the Greathead method used in building the City & South London road in London. In this method an iron shield, fitted with projecting cutters or scoops, is pushed forward by means of hydraulic rams into the soft gravel and sand which constitute the subsoil, and, with the help of water led into the excavating chamber through pipes, the combined water and sand, forming a mud or sludge, is drawn out through a large pipe by suction and discharged into suitable receptacles at the tunnel entrance. Following upon the progress of the iron shield, the cast-iron lining of the tunnel is built up, each section being composed of five segments jointed by bolts through flanges. Hydraulic cement is forced by air pressure into the space surrounding the sections as built up, thus forming a grouted exterior lining.

The tunnel proposed is only large enough to carry a single track, so that as many tunnels must be built as tracks are required.

Fig. 2 is a section showing the section of the tunnel, its general form, and the manner in which the cast-iron shell is built up. Figs. 3 and 4 give, on a larger scale, the bottom flanges in section, showing the way in which the rails are to be mounted and the cross-ties on which will be mounted the insulators carrying the power wires.



DESIGN FOR UNDERGROUND RAILROAD IN BERLIN, GERMANY.

It is said that these plans will probably be adopted, and that the work will be begun before long. The additional facilities are very much needed in Berlin, where a large and rapidly increasing population is crowded into very close quarters on account of the difficulty in reaching the suburbs.

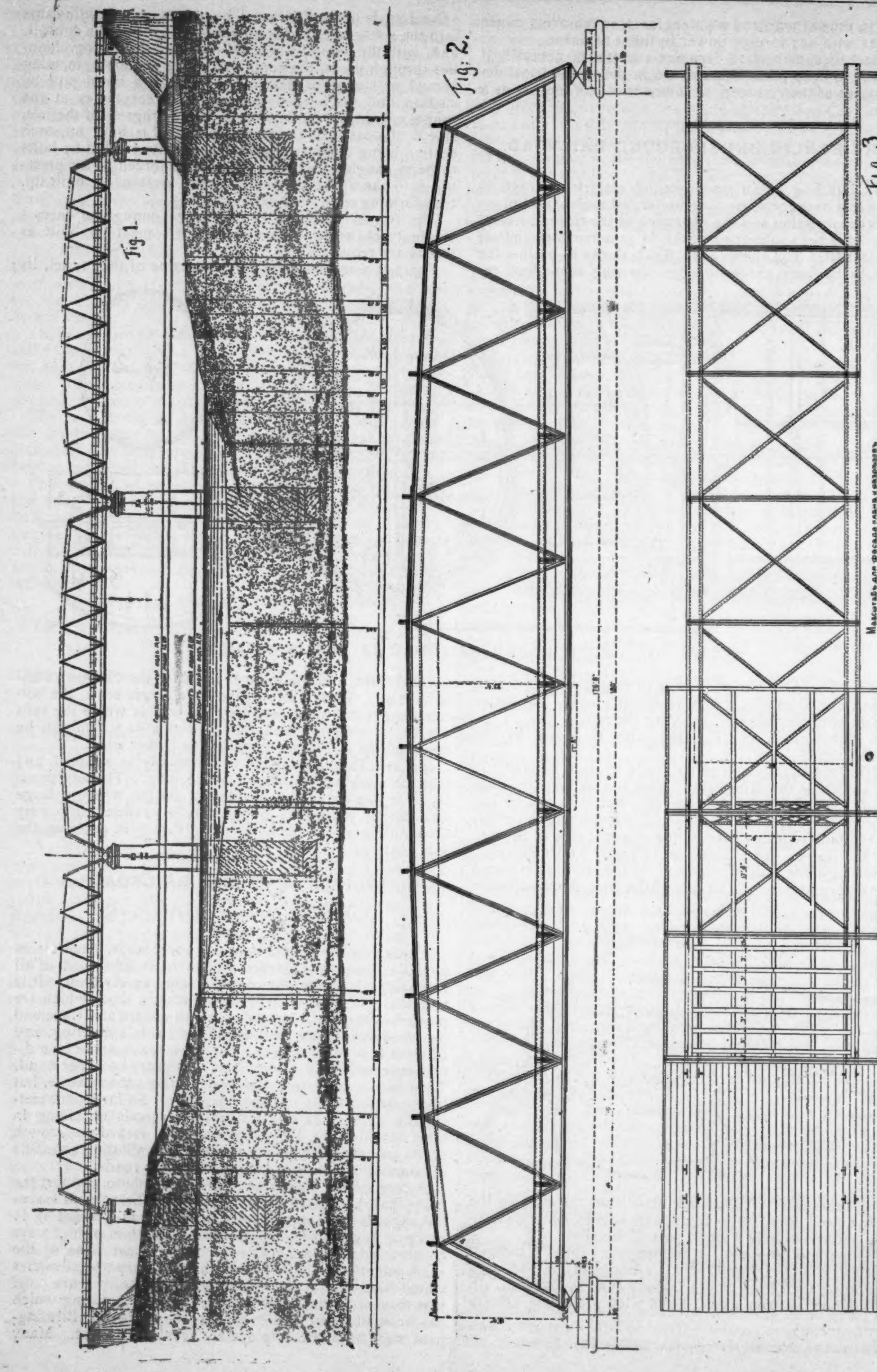
HIGHWAYS VERSUS RAILROADS.

(Professor N. S. Shaler in the *Atlantic Monthly*.)

JUDGED by the standard of our local ways, America as a whole must be regarded as the least advanced of all countries which are commonly classed as civilized. It is true that our great transportation routes, those which are plowed by the steamers of our inland waters and traversed by locomotives, are well organized, wide-spreading, and efficient in a high degree; but these ways serve in a direct manner only a narrow belt of country on either hand. They have a high interstate and international value, but little relation to the needs of local life. So far from meeting the necessities of rural neighborhoods or aiding in their development, they have tended to retard the growth of the less conspicuous but really more important channels of communication, our common country roads.

A very strong argument could be made to support the point that the United States would have been in all essential regards more prosperous than it is at present if, in place of its railroads, it had secured a system of highways constructed and maintained in the highest state of the road-maker's art. It is true that our export industries would have been much less important than they are now. It is true also that a prosperity in manufacturing which has brought great bodies of our people to the Birmingham state of hived employment would not exist. Many

* This road was described in the JOURNAL for May, 1887.



BRIDGE OVER THE RIVER NIEMEN AT OLITA, RUSSIA; DESIGNED BY PROFESSOR N. A. BELELUBSKI.

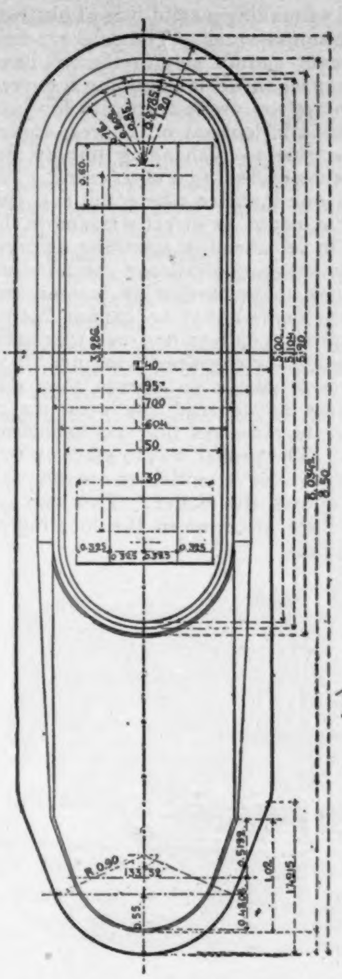


Fig 6

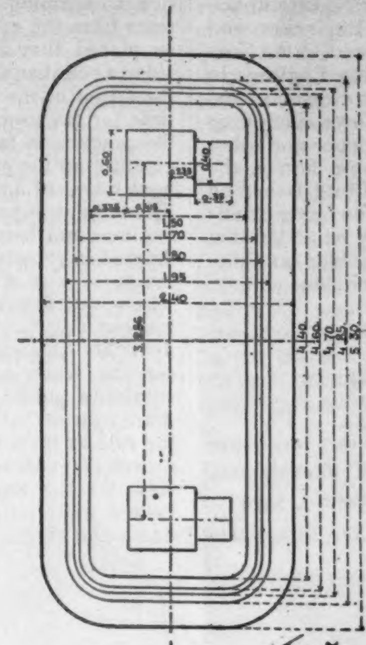


Fig. 7.

DETAILS OF NIEMEN BRIDGE.

of our cities would be but country towns, and the buffalo would still roam over much of the country to the west of the Mississippi. On the other hand, our farmers would know more of one another than they do at present. Though they could not market their corn in Liverpool, they would still be able to take it to mill without the sore tax which the bad roads so generally levy upon them, or which the toll-taker requires as the price of a passable way. In such a well-united community, distance counts for little against the duties of life, or against those pleasures which are in the higher sense a part of human obligation. The farmers could attend their town meetings, if they were so fortunate as to live in a part of the world which is governed by local parliaments. They could do their duty by the churches, and have a share in the festivities which enliven and enlarge their days. On the contrary, where the roads are bad, all the duties of the citizen and the social being are most imperfectly done. The people get in the habit of a hermit life; the winter season, which should be the season of social intercourse, is passed in seclusion; households have but little touch with one another, and any real communal life becomes impossible.

A RUSSIAN HIGHWAY BRIDGE.

THE drawings given herewith show a highway bridge over the River Niemen, near Olita, in Russia, on the line of the great national road known as the Strategic Road. This bridge was recently completed, having been formally opened for travel in October.

As shown in the general elevation, the bridge consists of five spans supported by two abutments and four piers of masonry. At each end there is a short plate-girder span, 44 ft. in length; the three remaining spans are of equal length, each being 25.7 sagènes (176 ft. 8 in.) long. The distance between the centers of the piers is 180 ft. The main roadway is 21 ft. wide in the clear between the trusses, and there is on each side, outside the trusses, a footwalk 3 ft. 6 in. wide.

In the drawings, fig. 1, as above stated, gives a general elevation of the bridge, showing all the spans. Fig. 2 is an elevation, and fig. 3 a plan of one of the long spans; fig. 4 is a cross-section and fig. 5 an end view of the span; fig. 6 is a plan of one of the river piers and fig. 7 a plan of one of the shore piers.

The general design of the long spans, the method of bracing and the floor system are so clearly shown that but little description is needed. The bridge superstructure is entirely of iron. The dimensions in fig. 1 are in Russian sagènes, but in figs. 2–5 they are given in English feet.

The foundations of the two river piers are carried down to a depth of about 60 ft. below the river-bed. The subsoil is chiefly sand, gravel and bowlders, with some layers of clay, and the bed-rock is about 70 ft. below the river-bed. A substantial foundation was obtained, however, without going down to that depth.

The bridge is an example of the latest and most approved practice in Russia, and is interesting as showing the ideas prevalent among the engineers in that country, where there are many points of similarity to our own.

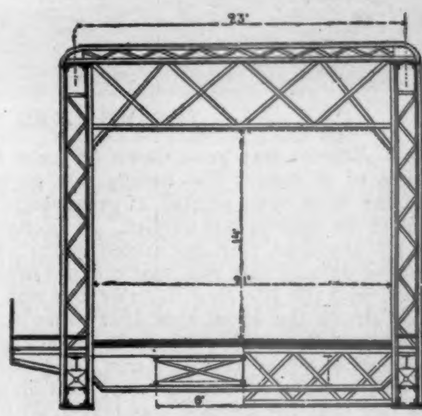


Fig. 4.

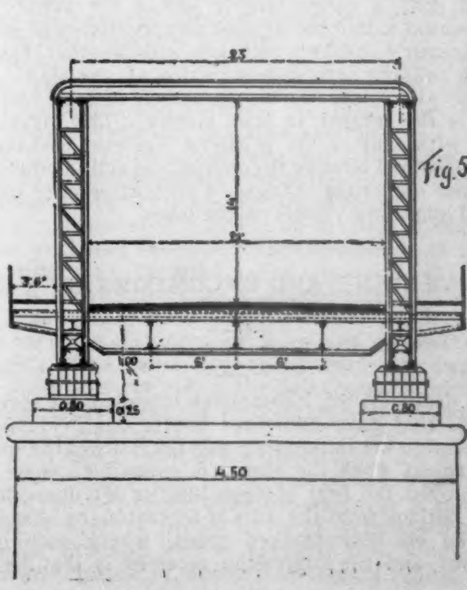


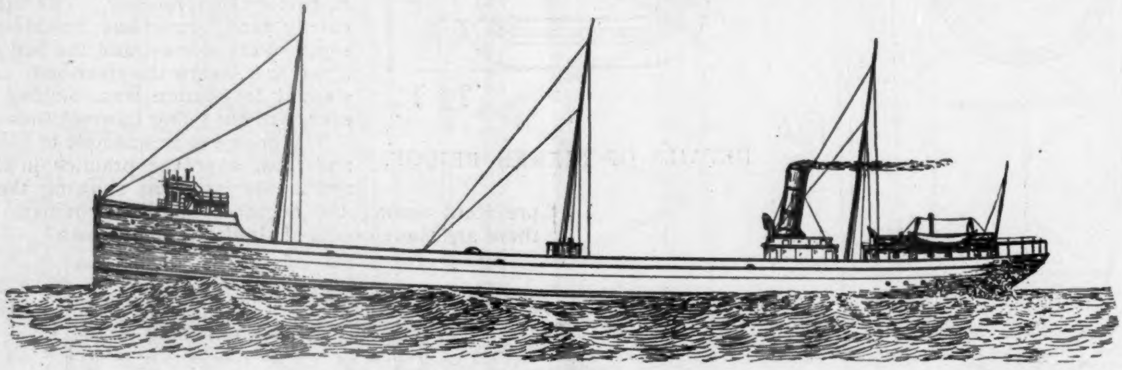
Fig. 5.

The designer of this bridge was Professor N. Belelubski, Chief of the Russian Imperial Institute of Engineers, and Director of the physical laboratory maintained by the Government. Professor Belelubski is Consulting Engineer to the State Department of Roads and Communications, and has designed a number of important structures, including the great bridges over the Volga, the Dnieper and other rivers. He has recently received a notable honor, the number of the *Annals* of the Imperial Institute issued on the twenty-fifth anniversary of its organization being chiefly devoted to an account of his work. It may be added that the designs of the numerous bridges required for the Siberian Railroad will be made under his supervision.

A LOST LAKE STEAMER.

THE illustration given on this page shows a large lake steamer whose total loss recently is still unexplained. The *Marine Review*, from which we take the cut, says:

Another big steel steamer, the *W. H. Gilcher*, a duplicate of the *Western Reserve*, has gone down on Lake Michigan with a crew of 18 men. The details that go to confirm the disaster have been printed at great length, and little remains to be said in this regard. It is, however, certain that all practical men connected with the lake marine are of the opinion that this boat did not break up, as was the case with the *Western Reserve*, but was either in collision or struck the shoal spot four miles south of South Fox Island, in the vicinity where the wreckage was found, and where the vessel certainly met the great force of the storm on the night of October 28. This opinion is based on the fact that the steamer was loaded with 3,000 tons of coal, a cargo largely within her capacity, and which would stiffen her against any possibility of foundering, excepting through collision with another vessel, or through running onto an obstruction of any kind. Aside from the awful loss of life, the money loss on vessel and cargo is the largest in lake history. The disaster, together with that of the *Western Reserve*, will open up many questions relative to construction and insurance that will cause numerous changes in present practice in building and operating vessels on the lakes.



THE WRECKED STEAMER "W. H. GILCHER."

INCONVENIENT AND UNCOMFORTABLE LOCOMOTIVES.

(From *Locomotive Engineering*.)

THE designers of locomotives intended for service on railroads that have numerous curves ought to take into consideration the importance and necessity of the engineer seeing ahead when the engine is rounding a curve. We have enjoyed the best of opportunities for observing the limited outlook from the cabs of a great many locomotives employed on very crooked roads, where cuttings are numerous, and the impression received is that the practice is becoming general of making a solid line of obstructions from the cab to the smoke-stack. The cabs are now so placed that an engineer cannot step to the left-hand side to see that all is clear when he is rounding a curve; the duties of the fireman are too arduous to give him any time for keeping a systematic lookout on curves, and so the practice is for the engine to rush along blindly, depending on the good fortune of finding a clear track. We have heard of more than one instance where tail-end collisions have happened that could be directly traced to the engineer not being able to see ahead in rounding a curve. There is a growing sentiment among railroad commissioners to require a third man to be carried on locomotives where the fireman is so located that he cannot keep a lookout ahead. When juries begin to find out that accidents are happening through the engineer b ing unable to see the reach of the track visible on curves, they will stimulate public sentiment to demand the presence of more eyes on the monster locomotives that are becoming the rule as train haulers. The proper way to stave off this source of expense is the devoting attention to opening the view for the engineer across the boiler. This can be helped materially by a little attention to the locating of dome and sandbox.

Another thing that demands attention is the location and width of the cab. Many cabs are made as if they were intended for liliputians, a man of moderate size having to squeeze himself to get in position to reach the working levers. This may be quite comfortable as viewed from the drawing office, and it entails no great hardship upon the man who goes in inspecting the arrangement when the engine is cold in the builder's shop. On the road it is a different matter. With hot weather and the intimate proximity to a hot boiler, the man in the cab is parboiled during a great part of the time he is at work. Is it surprising that the man who is subjected to this ordeal, day after day, gets convinced that engineers are a poorly paid class considering the discomforts they have to endure? A very little forethought and no extra expense would make the cab comfortable. Apart from humanitarian considerations we believe that it would pay railroad companies to effect a reform in the locomotive cabs.

A SWISS COMPOUND LOCOMOTIVE.

THE accompanying illustration, from *Industries*, shows a compound locomotive for passenger service recently built for the Jura-Simplon Railroad in Switzerland by the Swiss Locomotive & Machine Works at Winterthür. The road has a large passenger traffic in summer and the heaviest of this has to be worked over several sections with heavy grades and many sharp curves.

The standard locomotive which the Jura Simplon Company has adopted for this work is of the American type, with four driving-wheels and a four-wheel truck. The company has already in freight service a number of compound engines of the Mallet two-cylinder type. For passenger service the locomotive shown is a new departure; it is a two-cylinder engine, but has a starting-valve of the Von Borries type, which admits steam from the boiler di-

rectly into the low-pressure cylinder, but closes automatically and begins the compound working without the action of the engine-driver.

The high-pressure cylinder of this engine is 17.69 × 25.57 in. and the low-pressure 26.38 × 25.57 in., the proportion of the cylinders being 1 : 2.2. The steam-chests are placed above the cylinders, and the valve-motion for both cylinders is of the ordinary shifting link type. The valve-rods are worked from rocker arms, and the valves are of the Allen pattern. The reversing gear is moved by a screw and hand-wheel.

The frames are of steel plate 1 in. thick, and the cross-bracing is unusually strong and stiff. The steam reservoir between the two cylinders is in the smoke-box, and consists of a pipe of an arched form; the steam-pipes from the boiler are also placed in the smoke-box.

The driving-wheels are 72.13 in. in diameter, one pair being in front and one back of the fire-box. The driving-axles are 8 ft. 6.31 in. apart between centers, and the distance from center of forward driver to center of truck is 11 ft. 1.19 in.

The truck is of the swing-bolster pattern, with plate frame. The truck wheels are 40.5 in. in diameter, and the truck axles are 7 ft. 2.58 in. apart between centers. The truck frames are of steel, and that material has been used wherever possible in the engine. The crossheads are of cast steel.

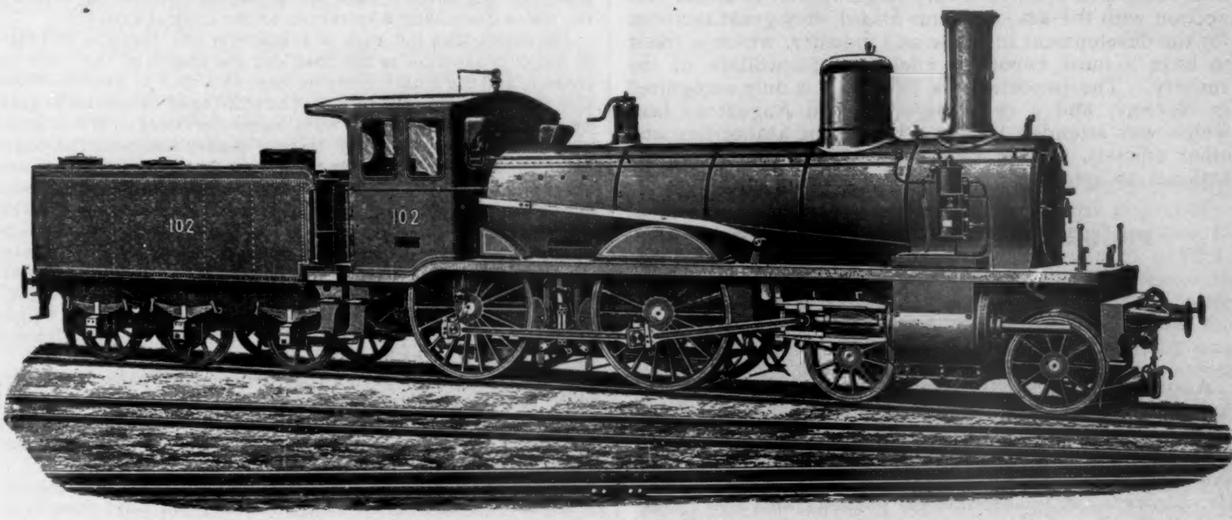
The boiler is 52½ in. in diameter, and has 224 tubes, 1¾ in. in diameter and 12 ft. 5.58 in. long. The fire-box is of copper, the roof being curved and the crown-sheet stayed to the outer shell by radial stays. The grate area is 21.4 sq. ft., and the heating surface is: Fire-box, 97.4; tubes, 1,286.2; total, 1,383.6 sq. ft. The boiler is built for 170 lbs. working pressure.

The total length of the engine over all is 32 ft. 2 in. Its weight in working order is 105,950 lbs., of which 63,600 lbs. are carried on the drivers and 42,350 lbs. on the truck. The tender weighs 66,750 lbs., and has a total length of 19 ft. 3 in.

The tender is carried on six wheels 40.5 in. in diameter. The frame is of steel plate. The tank has a capacity of 3,640 gallons of water, and the coal box will hold about 9,000 lbs. of coal.

On the trial trip this engine took a train weighing 257 tons, including weight of engine and tender, up a long 1 per cent. grade, maintaining a uniform speed of 30 miles an hour, with an abundant supply of steam.

The engine is fitted with Haushalter's recording speed indicator, driven from the right-hand coupling-pin, and with Gresham's steam sanding apparatus, fed from sand-boxes beneath the foot-plate, while an apparatus is supplied for washing the rails in the numerous tunnels occurring on the line, especially in the Jura sections. It is equipped with the latest quick-acting Westinghouse brake, the air-pump being placed, as will be noticed, on the smoke-box. On the engine both driving wheels are acted upon by the usual toggle-joint apparatus, in connection with a 6-in. brake cylinder on each side. The tender has brake-blocks on each side of the wheels of the leading and trailing axles.



COMPOUND EXPRESS LOCOMOTIVE FOR THE JURA-SIMPLON RAILROAD.

A NORWEGIAN CANAL.

(From *Industries*.)

THERE has just been completed in Norway a work of which very little has been heard in this country, but which has many most interesting and difficult engineering features, and which is likely to have most important results on the commerce and industry of that country. There has been constructed a magnificent canal, or, more properly speaking, a series of locks and weirs, by which a large and rapid river has been canalized and transformed into a useful water highway, thus opening out a large part of the great watershed of Thelemarken, and placing the heart of southern Norway in direct communication with the sea.

We will content ourselves for the present with a brief outline of this scheme, and a few remarks on its commercial aspects. About midway between Christiania and Christiansund there is the port of Langesund at the mouth of a fjord leading to the ports of Porsgrund and Skien, the latter being about 17 miles inland and connected with the large Nordsjo Lake by a short stretch of river. About half-way up this lake there is the village of Ulefos, the seat of an important iron industry. This lake is joined by a river to a chain of lakes consisting of Flauvand, Hoiteseidvard, and Bandakvard, all coming generally under the latter appellation, and forming the receptacles for the water collected from an immense watershed. The problem which had to be solved was the canalization of the connecting rivers and the lakes so as to afford a continuous outlet from the center of the country to the sea. This was a work of considerable difficulty on account of the differences of level, and the consequent magnitude of some of the constructions required. For instance, at Ulefos, where the canalizing of the river commences, there is a set of three locks and an aqueduct, by which the canal is carried for some distance past a weir and waterfall 36 ft. in height. Two miles further up there are two more locks, which are cut out of the solid granite, and which enable vessels to enter the river again a short way above the Eidsfos—a fall of 33 ft.

The most difficult part of the undertaking was at a place called Vrangfos, where, by means of five locks and an extra one for use in flood time, the waterway is carried up a height of over 75 ft. In order to regulate the upper waters, an immense weir of masonry had to be formed, and the succession of shoots and rapids which existed

were thereby converted into a perpendicular fall of water, a piece of construction which required very great care. A series of smaller locks completes what is necessary to open the navigation to the Bandak Lake, and, so far as can be seen, the whole work has been judiciously planned and carefully carried out. The cost of the undertaking was about $780,000, but a considerable sum will still be required for dredging and the formation of dykes. The total length of the canal from Ulefos to Strengen is nearly 14 miles, and the principal dimensions of the locks are as follows: Length, 124 ft. 8 in.; breadth, 26 ft.; and minimum depth on sills, 9 ft. 3 in.

The great Lake Nordsjo, from which the canal starts, was connected with the sea so far back as 1861, by means of two locks at the town of Skien, and four other locks between that and the lake, so that the work which has now been carried out is a completion of an undertaking commenced more than 30 years ago. The series of lakes thus connected open up a very large district to direct connection with the sea, and thus afford very great facilities for the development of trade and industry, which is likely to have a most important effect on the welfare of the country. The importance of the work is duly recognized in Norway, and a ceremony was held August 20 last, which was attended by the Government authorities and other officials, to celebrate the completion of this great national undertaking.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page 512.*)

About the year 1875 paragraphs were floating in the American newspapers concerning the "California flying machine," which was said to be under construction in San Francisco. This was the design of Mr. *Marriott*, of the San Francisco *Newsletter*, formerly a fellow-worker with Mr. *Stringfellow* in aeronautical pursuits, and also a resident of Chard.

Mr. *Marriott* had already experimented in 1867-69 with an elongated balloon, provided with attached aeroplanes, from which he expected to obtain additional sustaining power when at speed—a system which has been many times proposed, and which is often brought forward again by inventors who are not aware of the prior experiments.

Mr. *Marriott's* balloon model was 28 ft. long, 9½ ft. in diameter, with aeroplanes extending for half its length, and was to be driven by a light steam-engine, rotating a propeller 4 ft. in diameter 120 times a minute. The utmost speed that could be obtained was five miles per hour, and as this was not sufficient to stem the winds that constantly prevail in San Francisco, the inventor turned his attention to a design for an aeroplane.

This is said, in the report of the Aeronautical Society of Great Britain for 1875, to have consisted of three planes, superposed longitudinally, with an interval between them of about 10 ft. In transverse length the whole structure was to be 120 ft. fixed upon a foundation of trussed bamboo, the planes being unequal in size, the largest on the top being of the above dimensions and about 40 ft. wide, the three planes being rigidly supported by two masts about 40 ft. high and stayed by wire rigging.

To the lower end of each mast were to be affixed small wheels, to run down an inclined rail, in order to impart the necessary initial velocity to the apparatus, and this impulse was then to be continued by means of a steam-engine enclosed in a square compartment capable of holding the engineers. This compartment was to be located in the center of the trussed bamboo keel. The engine was to work four screw propellers, two of them vertical and two horizontal, their place of working breaking up the continuity of the longitudinal planes. The weight of the whole machine was estimated at 1,500 lbs., including the motive power and the engineer.

No drawings or detailed description of this aeroplane were ever published, the inventor's idea being to keep his plans secret until he had made a success of the machine. It was never completed, for Mr. *Marriott* sickened and died before the apparatus was ready for trial, and his associates did not care to risk the great outlay which would have been necessary to test so large and expensive an apparatus. The weight of the motor and the equilibrium would have been the stumbling-blocks.

At the meeting of the Aeronautical Society of Great Britain for 1876, M. *Sénécal* gave some notes on the stability of aeroplanes of different forms, which he illustrated with paper models, and these experiments are so easily reproduced that the following account of them, quoted from the report, will probably prove interesting:

> He said that while planes of even width and thickness (load uniformly distributed) revolve upon their own axes, and their path of translation is rectilinear, the motions of triangular planes are much more complicated. These planes are obtained by dividing the circumference into blades of different widths. These blades, besides revolving upon their axis, rotate also round a vertical conic axis, whose base is upward, the vertex of the plane describing a spiral round the conical axis.
>
> He found that the rate of revolution and rotation increases in direct proportion as the base and the length of the blade decreases, and the length traveled over in a unit of time decreases also in the same proportion. The shifting of the center of gravity (pressure ?) of these blades is most interesting. It was found that the center of gravity of narrow planes was near the vertex and on the edge of the plane, but recedes toward the base and axis as it widens; it also travels from the axis toward the edge and vertex as the rate of revolution increases, and possibly that, at high velocities of rotation, the center of gravity will be beyond the edge. The size of blade that revolves and rotates most steadily represents the eighteenth to the twenty-fourth part of the circumference. He also proved that by cutting a small plane out of the base it had the same effect as applying a weight at that point before cutting it. The plane will then revolve and rotate round with its base turned toward the vertical axis.
>
> He also liberated several narrow strips of paper, showing, while revolving, nodal and ventral sections similar to musical strings in vibration, the number of aliquot parts increasing with the length of the ribbons and disappearing as the width increases.
>
> M *Sénécal* then enunciated the following law: that planes, of whatever form, but of even thickness and rigid margin, in order to translate steadily must carry their maximum load on a line representing the first third part from the anterior margins of the plane; but one can, with impunity, apply graduated weights from that line right on to the edge, and, in some instances, a good distance beyond the edge, and high rate of speed is the result. The rate of translation increases directly with the load placed on the different points of the graduations from that line of the center of gravity.

While the account of the action of these paper planes is not very clear, it is sufficiently so to permit the curious in such matters to repeat the experiments, and these will be found more instructive than any description of the results, however accurately expressed. The action will be found to be greatly modified by slightly folding the back edges as already described.

In 1877 Mr. *Barnett*, of Keokuk, Ia., patented in the United States a flying machine somewhat similar in arrangement and principle with that of *Pénaud* and *Gauchot*. It consisted in an aeroplane something like a boy's triangular kite, but with the two longitudinal halves set at a diedral angle from the central spine or spar, in order to obtain lateral stability. Just under this kite a boat-shaped car was to be affixed, carrying the motor, which was to rotate two propellers mounted upon shafts at the front of the apparatus, and turning in opposite directions. An adjustable tail was to carry part of the weight and to regulate the angle of incidence, the car being provided with wheels so as to run over the ground until the speed was great enough to give a sustaining reaction.

This design is not without merit, but it leaves unsolved the two principal problems concerning aeroplanes—*i.e.*, the providing a light motive power, which shall not weigh more in proportion than that of the birds in ordinary flight, say 20 lbs per horse power, and the providing for automatic stability, which, as already explained, should be greater for an inanimate machine than for a live bird. The form of the triangular kite is not stable, as many a boy has found out to his sorrow by providing an insufficient tail, and if the kite form is to be used, it will proba-

bly be best to experiment with shapes that fly without a tail, some of which will be noticed hereafter.

Mr. *Barnett* is understood to have tried many experiments, extending over a period of 30 years. He first constructed a plain flat kite some 12 ft. long and 10 ft. wide, under which was hung a frame so as to attach and adjust the mechanism for turning two propellers rotating in opposite directions. This machine was not placed on wheels, but he was much pleased with the clutch that the propellers took on the air. Next he constructed an apparatus to carry the weight of a man. This consisted of a kite or aeroplane of canvas 27 ft. square, from which hung a propelling arrangement somewhat similar to that shown by Mr. *Maxim* in the *Century Magazine* for October, 1891, as the manner of connecting the aeroplanes and attaching the screws in his experimental apparatus. This machine was placed on wheels, being the running gear of a light spring wagon, and as Mr. *Barnett* knew of no motor sufficiently light for actual flight, he determined first to experiment with his own muscular power.

The propellers were two bladed, each blade being of oil-cloth and a sector of a circle, or like a piece from the ordinary round pie. The operator was beneath and rotated them through appropriate gearing. He ran the machine along smooth country roads, but as soon as speed was gained, the increasing air pressure, acting forward of the center of figure, in accordance with the law of *Joëssel*, already given, would tip up the front of the aeroplane and disturb the equilibrium. This led the inventor to believe that the propellers were too far below the aeroplane, and he altered their position, but without any better result; the machine would still tip backward, presenting a greater angle of incidence, and increasing the resistance. Moreover, it would not keep to the line of the road, but, as it was propelled, would run off to either side into the grass, weeds or uneven ground, swerving in a way which would have involved great danger if it had been able to rise into the air.

Picking out a quiet evening, near dusk, the inventor determined to give it an extra good test over smooth ground, and while apprehensive that if it left the earth it might lurch and come to grief, he managed by "main strength and awkwardness" to get under considerable headway, when the front end tipped up so much as to break and splinter the main support, and the inventor came very near getting hurt.

This terminated the experiments with that machine. Subsequently the inventor entered it for exhibition at the State fair as an "automatic kite," and he says quaintly that he entered, at the same time, some samples of tomatoes, cabbage and grapes of his own growing; received a premium on the tomatoes and cabbage, and favorable mention on the grapes, but concluded at the last moment not to take the "kite" to the fair ground, as it did not perform as he desired.

He has built two more machines of such dimensions as to support a man within the last six or seven years, and has tested them upon a smooth pasture, but found this, after many weeks of trial, too rough and uneven for his purpose. The tracks of animals, a bunch of grass, or a corncob would check the speed, so that with all his strength he could not arrive at sufficient velocity to leave the ground. This is not surprising, for Professor *Langley* has since shown that the best that can be done with a plane is to sustain 209 lbs. by the exertion of one horse power, and this without any hull resistance whatever, so that, as man cannot steadily exert much more than one-tenth of this power, a total weight of about 20 lbs. is the maximum that he can hope to support and drive through the air by the exertion of his own unaided strength.

Mr. *Barnett* has of course experimented with a considerable number of small models. He first tried clock springs, but found them too heavy; and all would-be inventors had better avoid wasting effort with them; next he tried twisted india-rubber, and while he found great irregularity in its action, he succeeded in obtaining a number of fair flights among many failures. He experimented with superposed planes, but the result was not satisfactory. His last model, produced in 1892, resembles his original design, and, driven by rubber bands, succeeded in getting a preliminary start by running over a platform 12 ft. long, slightly inclined, and flying through the air "above the hollyhocks and other flowers" until it struck the side of a house 30 ft. away, and 4 ft. higher than the platform.

India-rubber is a good reservoir of power to experiment with. The flights are brief, as the power is soon spent, but they give an opportunity of testing the equilibrium, the proportions, and the adjustment of the parts, which may suggest themselves to an experimenter as possibly efficient.

An apparatus patented in France by M. *Pomès*, in 1878, is represented in fig. 57. It consisted in two supporting planes in front, together with a keel plane, and a large

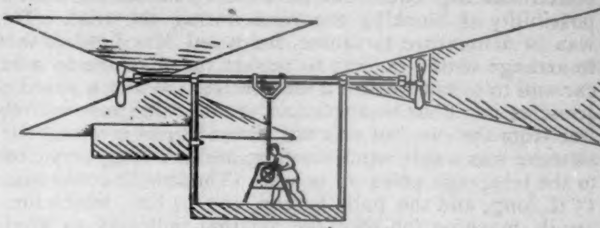


FIG. 57.—POMÈS—1878.

vane behind, to maintain the course. Two propelling screws on the same horizontal shaft were to impart motion, and although they are shown as actuated by hand on the figure, the same inventor had already patented, in 1871, in connection with M. *de la Panse*, a gunpowder motor, in which a series of charges, exploded by electricity, were made to pass through a tube and to impinge against the buckets of a revolving wheel, from which the motion was to be communicated to the propellers. Neither this motor nor the aeroplane possess merit, and indeed the latter is about as badly arranged as it can be, for as the air pressures which are to sustain the weight act with a leverage increasing toward the tips of the wings, or sustaining planes, the latter should taper in plan from the center of the apparatus outward, instead of tapering inward as shown in the figure, in order to obtain a light and strong construction. It is not known whether M. *Pomès* experimented at all, but if he did, it must have been with very small models, for his design is quite unsuitable for a large one, and has been here included in order to point out the deficiencies of such a design.

In 1878 Mr. *Linfield* constructed an apparatus to test *his* conception of an aeroplane. It consisted of plane surfaces extended on a framework 40 ft. × 18 ft. at its greatest width, and measuring about 300 sq. ft. in surface, the weight of the apparatus being 189 lbs. It was mounted upon wheels, and driven over a macadamized road by the action of a screw propeller placed in front of the machine, rotated at about 75 revolutions per minute by the aviator, working a treadle and levers with cross handles. Upon the highway, on an incline of about one in a hundred, a speed of 12 miles an hour was attained without any indication of a rise from the ground. Then by going down hill, a speed of 20 miles per hour was obtained, but still without perceptible effect, which is not be wondered at, for at this speed, with an angle of incidence presumed to have been 6°, the "lift" would be $300 \times 2 \times 0.206$, or, say, 123 lbs., while the weight including the aviator was over 300 lbs. It would have required an angle of 17°, at a speed of 20 miles per hour, to have produced sufficient "lift," while at that angle the "drift" alone would have required the exertion of 5 horse power, which the operator was clearly unable to furnish, it being "most dreadful exertion" to work the treadles at the flatter angle of incidence above presumed to have been experimented.

Subsequently Mr. *Linfield* built another machine upon a different principle. It was 20 ft. 9 in. in length, 15 ft. in width, and 8 ft. 3 in. high; the sustaining surfaces being in two frames, each 5 ft. square. Each frame contained 25 superposed planes of strained and varnished linen 18 in. wide and spaced 2 in. apart, thus somewhat resembling a cupboard without front or back, and with shelves very close together. These frames were slung on either side of a cigar-shaped car at its maximum section, being

set at a diedral angle to each other, so that the apparatus, could it have been seen in the air, would have resembled a huge cigar with a pair of saddle bags attached thereto. There was a nine-bladed screw at the front, and a guiding vane, like the tail of a dart, behind ; the entire sustaining surfaces in the two frames being estimated to aggregate 438 sq. ft., and the whole machine, which was mounted on four wheels, weighing 240 lbs., to which 180 lbs. must be added for the operator, thus providing a little over one square foot of sustaining surface per pound.

Mr. *Linfield* was to stand between the two front wheels and actuate two treadles to rotate the screw, which was 7 ft. in diameter ; but when the time arrived for testing the machine upon an ordinary macadamized road, it was stated that this could not be done on account of the impossibility of blocking the road during the trial. This was in a measure fortunate, for it led Mr. *Linfield* then to arrange with a railway to mount the machine on a flat car and to tow it behind a locomotive. When a speed of 40 miles per hour was attained the machine rose entirely free from the car, but was not allowed to swerve very far, as there was a side wind blowing, and it swung very close to the telegraph poles as it was. The tow line was some 15 ft. long, and the pull thereon was 24 lbs., which for a 240-lb. machine (without the aviator) indicates an angle of incidence of 1 in 10, or 6°. At this angle, and at a speed of 40 miles per hour, at which the air pressure would be 8 lbs. to the square foot, the total lift for a single plane ought to be $438 \times 8 \times 0.206 = 722$ lbs., so that, if the 240 lbs. of machine was just sustained, it indicates that the very narrow spacing (2 in.) between the superposed aeroplanes greatly interfered with their efficiency.

Mr. *Linfield* also tested the efficiency of superposed screws. He placed nine of them some 6 in. apart upon a vertical shaft. These were all with two narrow blades and 3 ft. in diameter, but in whatever relative position they were placed radially, he could get no greater lift from the nine screws than he could from the top and bottom screws only, 4 ft. apart, the seven intermediate screws being removed.

The idea of testing the apparatus by towing it on a railway car was evidently a good one, but this disclosed such inefficiency of lifting power and of stability as to put an end to the experiments.

We next come to a series of very careful experiments, tried by an able mechanician, which almost demonstrate that artificial flight is accessible to man, with motors that have been developed within the last two years. These experiments were carried on by M. *V. Tatin*, who was then Professor *Marey's* mechanical assistant. He first began with beating wings, and produced, in 1876, the artificial bird which has already been briefly noticed under the head of "Wings and Parachutes." This was driven by twisted rubber ; not only did M. *Tatin* find that the power required was unduly great, but he also found that this power could not be accurately measured, the torsion of india-rubber being erratic and stretching unequally. He constructed a large number of mechanical birds of all sizes and various weights ; he tried many modifications and entire or partial reconstructions, and finally concluded, after spending a good deal of time and money, to take up the aeroplane type, to be driven by a reservoir of compressed air. With this his efforts were successful almost from the first, and he produced in 1879 the apparatus shown in fig. 58, which is practically the first that has risen into the air by a preliminary run over the ground. This machine consisted in a silk aeroplane, measuring 7.53 sq. ft. in surface, being 6.23 ft. across and 1.31 ft. wide, mounted in two halves at a very slight diedral angle, on top of a steel tube with conical ends which contained the compressed air. This reservoir was 4¾ in. in diameter and 33⅛ in. long, was tested to a pressure of 20 atmospheres, and worked generally at 7 atmospheres ; its weight was only 1.54 lbs., and its cubical capacity 0.28 cub. ft. From this (the vital feature of the machine) the stored energy was utilized by a small engine, with oscillating cylinder, placed on a thin board on top of the tube, and connected by shafts and gearing to two propellers with four vanes each, located at the front of the aeroplane. These propellers were 1.31 ft. in diameter, and rotated in opposite directions some 25 turns per second, their velocity at the outer end being about 100 ft. per second. The vanes were of thin bent horn set at a pitch of about 1.50 ft., and they towed the apparatus forward instead of pushing it.

A tail of silk fabric 1.97 ft. across at the rear, by a length of 1.97 ft., was set at a slight upward angle and

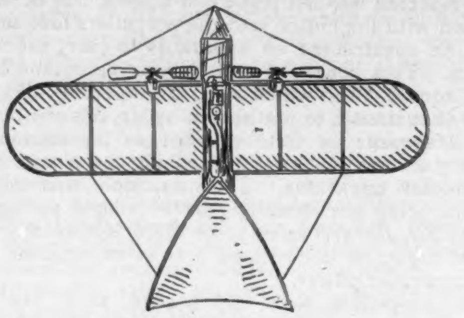


FIG. 58.—TATIN—1879.

braced by wire stays, in order to provide for the longitudinal stability upon the principle advanced by *Pénaud ;* and the whole apparatus was placed on a light running gear consisting first of four wheels, and subsequently of three wheels. The total weight was 3.85 lbs., so that the sustaining surface of the aeroplane (omitting the tail) was at the rate of 1.95 sq. ft. to the pound.

After a vast deal of preliminary testing and adjustment, the apparatus was taken to the French military establishment at Chalais-Meudon, where it was experimented with in 1879 upon a round board platform 46 ft. in diameter. Upon this the machine would be set upon its wheels, the front and rear ends being fastened to two light cords carried to a ring around a central stake, and the compressed air would be turned on to the engine. The propellers would put the apparatus in motion, and it would run from 65 to 165 ft. over the boards, until it attained a velocity of 18 miles per hour, when it would rise into the air, still confined radially by the two cords, and make a flight of about 50 ft., when, the power being exhausted, it would fall to the ground, almost invariably injuring the running gear in doing so.

The flights were not very high, but on one occasion the apparatus passed over the head of a spectator. The angle of incidence was 7° or 8°, and the power developed by the engine was at the rate of 72 33 foot-pounds per second, gross ; but as its efficiency was only 25 to 30 per cent. of the gross power, the effective force was at the rate of 18.08 to 21.70 foot-pounds per second, or, say, at the rate of 5 foot-pounds per second (300 foot-pounds per minute) per pound of apparatus.

This power was measured with great care, the machine being provided with a tiny gauge and tested repeatedly with a dynamometer. M. *Tatin* calls attention to the fact that the minuteness of the engine greatly diminished its efficiency, and that with large machines it would be comparatively easy to obtain 85 per cent. of the gross power developed. He draws the conclusion that his apparatus demonstrates that 110 lbs. can be sustained and driven through the air by the exertion of 1 horse power—a most important conclusion, which will be further discussed hereafter.

To return, however, to the experiments : they are described as follows by M. *Tatin*.*

I will pass without description a series of preliminary experiments which led me to modify certain details, until all conditions were favorable. I then had the satisfaction of seeing the apparatus start at increasing speed, and in a few seconds the carriage barely touches the ground ; then it leaves it entirely at a speed of about 18 miles per hour, which agrees closely with the calculations. It describes over the ground a curve similar to those described by small models gliding freely, and when it comes down after its orbit, the shock is so violent as to injure the running gear. This accident recurred upon each experiment carried out under the same conditions ; the carriage was soon destroyed, and even the propellers were injured, although

* *Aéronaute*, September, 1880.

they could be repaired. I then tried another experiment, which I had already attempted several times without success, in consequence of inadequate preparation. The apparatus, the running gear being removed, was suspended by two grooved wheels running freely over an iron telegraph wire 260 ft. long, stretched as rigidly as practicable. When the speed became sufficient, the apparatus rose, and then one of the propellers struck the iron wire; the front grooved wheel overtook the machine, and the propeller was destroyed. These accidents caused no repining, for they demonstrated that in all cases the apparatus had completely overcome the force of gravity.

In order to continue the experiments I built a new carriage and new propellers, hoping to make them strong enough to stand the shocks during a new set of experiments, from which to deduce accurately the work done. The new running gear had but three wheels, these being larger and lighter than the old. The propellers, on the other hand, were made heavier, but modified so as to rotate more easily. Their vanes were made of a thin sheet of horn bent hot to the proper curvature. The inner two-fifths from the hub consisted of steel wire, this portion of a propeller requiring much force for rotation, and giving out but small effect toward propulsion; but the diameter and the pitch were the same as formerly.

I was, unfortunately, unable to make all the experiments I desired with this repaired apparatus. I intended to study the results with various angles of incidence in the planes and various pitch of the propellers; then to study the important question as to the best proportion between the sustaining surface and the diameter of the propellers; and lastly the speed of translation which will best utilize the force expended.

I was nevertheless enabled to deduce the following figures from my experiments. These figures are not absolutely exact, but sufficiently so to serve as a guide to others who may wish to engage in similar work. Calling A the sustaining surface in square meters (without the tail), and V the speed of translation in meters per second, then we may say:

$$\text{Lift} = O.\ kg.\ .045\ A\ V^2.$$

And the motor will need to develop effective work at the rate of 1.50 kilogrammeters per kilogramme of the weight (4.935 foot-pounds per second per pound), which corresponds to one horse power for each 110 lbs. weight of the apparatus.

These experiments seem to demonstrate that there is no impossibility in the construction of large apparatus for aviation, and that perhaps even now such machines could be practically used in aerial navigation.

Such practical experiments being necessarily very costly, I must, to my great regret, forego their undertaking, and I shall be satisfied if my own labors shall induce others to take up such an enterprise.

The effective work done by this aeroplane having been accurately measured, it affords a good opportunity of testing the method of estimating resistances which has been proposed by the writer in estimating the work done by a pigeon.

The weight of M. *Tatin's* apparatus was 3.85 lbs. Its aeroplane surface was 7.53 sq. ft., the angle of incidence was 8°, and the speed was 18 miles per hour, at which the air pressure would be 1.62 lbs. per sq. ft. Hence we have, by the table of "lift and drift":

$$\text{Lift, } 8° = 7.53 \times 1.62 \times 0.27 = 3.29 \text{ lbs.},$$

which indicates that a small part of the weight was sustained by the tail.

The hull resistances are stated by M. *Tatin* to have been almost equal to that of the plane. These hull resistances would consist of that of the tube, of 0.12 sq. ft. midsection, which, having conical ends and parallel sides, will have a coefficient of about one-third of that of its midsection. The resistance of the wheels and running gear will be slightly greater, but must be guessed at, as the wheels would continue to revolve through inertia and thus increase the resistance.

The front edge of the aeroplane, which was of split reed and about one-eighth of an inch thick, was 6.23 ft. long; but as the back edge of the aeroplane and the side borders of the tail would also produce some air resistance, we may call the edge resistance as equal to 6 ft. in length, by a thickness of 0.01 ft., without any coefficient for roundness. We then have the following estimate of resistances:

RESISTANCE OF TATIN AEROPLANE.

Drift 8°	$- 7.53 \times 1.62 \times 0.0381$	$= 0.4648$ lbs.
Tube	$- 0.12 \times 1.62 \div 3$	$= 0.0648$ "
Wheels and gear	— estimated	$= 0.1000$ "
Edges of wings	$- 6 \times 0.01 \times 1.62$	$= 0.0972$ "
	Total resistance	$= 0.7268$ "

and as the speed was 18 miles per hour, or 26.40 ft. per second, we have for the effective power required:

$$\text{Power} = 0.7268 \times 26.4 = 19.19 \text{ foot-pounds per second,}$$

which agrees very closely with the 18.08 to 21.70 foot-pounds per second said to have been effectively developed, and is at the rate of 5 foot-pounds per pound of apparatus, or of 110 lbs. of weight per horse power.

This last is the important point. Now that Mr. *Maxim* has produced a steam-engine which, with its boilers, pumps, generators, condensers, and the weight of water in the complete circulation, weighs less than 10 lbs. to the horse power, aviation seems to be practically possible, if only the stability can be secured, and an adequate method of alighting be devised.

(TO BE CONTINUED.)

THE FIRST LIGHTSHIP WITH ELECTRIC LIGHTS.

IN the RAILROAD AND ENGINEERING JOURNAL for August, 1891, pages 361-64, there was given an illustrated description of Lightship No. 51, designed for the United States Lighthouse Board, the first vessel of her class to be supplied with electric lights. The ship has since been built by F. W. Wheeler & Company, at Bay City, Mich., and will soon take her place off Cornfield Point in Long Island Sound. To complete the account of the vessel we give below an account of the lighting plant, for which we are indebted to the courtesy of the *Electrical Engineer*.

LIGHTSHIP NO. 51, WITH ELECTRIC LANTERNS.

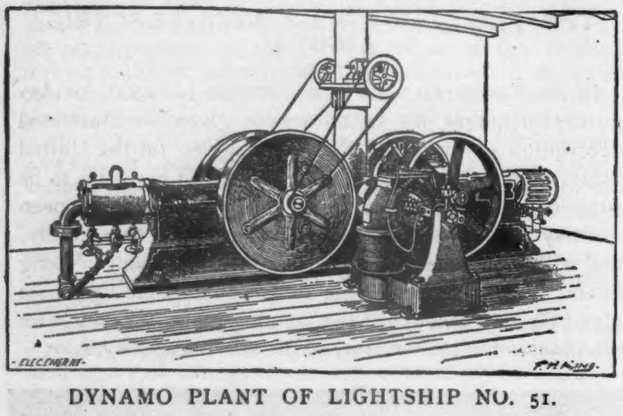
Lightship No. 51 has been fitted with a complete electric plant under the direction and at the suggestion of Commander Coffin, and in accordance with the specifications of Major D. P. Heap, U. S. Engineers, Engineer of the Third Lighthouse District.

Commander Coffin and Major Heap have long been firm in the belief that the incandescent electric light was perfectly adaptable to lightships, certain authorities to the contrary notwithstanding, though the white rays of the arc light are said to be more readily absorbed by fog than those of the oil lanterns in general use, the latter having a yellowish tinge that shows in a fog by contrast.

The incandescent light has, therefore, been employed on No. 51, and the utmost care has been taken to foresee

and provide for all possible accidents to any part of the plant. The entire equipment is in duplicate. The dynamo-room, consisting of a deck-house at the foot of the after mast, contains two Thomson-Houston dynamos wound for 110 volts and having a capacity of 100 lights each. These are driven by two Ideal engines of 8 H.P. each, running at 400 revolutions per minute. The dynamos are fitted with Evans friction cones, and the arrangement is such that each engine can run either generator or both, if desired, the change being made very rapidly by means of double-acting ratchets and sliding bed-plates. The actual floor-space occupied by the dynamos and engines does not exceed 9 × 8 ft. Each dynamo is amply capable of lighting the entire vessel by itself, but two are used for the sake of safety. If desired, either generator can furnish current to the masthead lights and the other one to the lamps below decks, and, in fact, the whole system is entirely interchangeable. Duplicate armatures and rheostats are kept ready for emergencies in addition to such accessories as brushes, switches, fuse blocks, etc.

The mast-head lights consist of eight 100-candle-power lamps, four on each mast in multiple. Each lamp is placed in a separate lantern with the triple loop of its filament in the focus of the lens, and the four lanterns are symmetrically placed about the mast-head. Lead-covered Habirshaw cables of seven strands imbedded in the masts



DYNAMO PLANT OF LIGHTSHIP NO. 51.

carry the current to these lights. If, in spite of all the precautions that have been taken, the electric plant, or a part of it, should become disabled, the lamps may be quickly removed from the lanterns, the sockets instantly moved out of the way, and oil lamps substituted while repairs are being made. The lanterns, it should be added, are swung on trunnions to keep the beam of light horizontal. In order to distinguish one from another, light vessels, as well as lighthouses, are provided with revolving lenses, making flashes of a certain duration; thus a ten-second flash with a five-second interval may show the pilot who has lost his bearings that he is not far from the right course, while a 20-second flash and a 15-second interval show him that he is near a dangerous reef. The combinations are infinite in number, and each has its especial significance. In this instance, however, instead of the heavy revolving lens operated by a separate engine and requiring careful attention, a very simple interrupter is used, regulating the length of the flash to a nicety, and entirely automatic in its action. This little device consists of a ratchet-shaped cam revolved by means of worm gear at a speed of one complete turn a minute, and divided into the proper number of steps to produce the particular number of flashes required. The gearing is run by a light helical wire belt from the engine shaft. The cam is made of hard wood with every alternate step covered with copper, and upon its face bear two brushes side by side, but insulated from one another, and included in the mast-head circuit. As the cam revolves, therefore, the circuit is alternately closed and opened at sharp intervals. The whole apparatus is only about 10 in. in height and stands on a little bracket above the dynamos. The flashing device also throws in a resistance equal to the resistance of the mast-head lights. When the latter are extinguished, this prevents the other lights in the ship from flickering.

The wiring of the entire vessel is most carefully and thoroughly done. About twenty lights are used for the necessary illumination between decks. In all cases, the wire is capable of carrying twice the current required without heating, and no effort has been spared to make this installation perfect in every respect. The success of the experiment is a subject for sincere congratulation to all who go down to the sea in ships, and to the electrical engineer, who sees in this experiment another glimpse of the vast possibilities of his profession.

THE UNITED STATES NAVY.

THE new cruiser *Olympia* was successfully launched at the Union Iron Works, San Francisco, November 5, and the *Cincinnati* at the New York Navy Yard, November 10. Both of these ships have been described and illustrated in recent numbers of the JOURNAL.

THE NAVAL RESERVE.

Information has reached the Navy Department that preliminary steps toward the organization of a naval militia have been taken recently in the States of Pennsylvania and Vermont. There are already eight States with properly equipped and creditable naval reserve forces organized in conformity with the national law and receiving aid from the Federal Government. They are Massachusetts, Rhode Island, New York, Maryland, North Carolina, South Carolina, Texas and California. The growth of this branch of the national defense has been extremely gratifying to the Navy Department, and in view of the increased demands upon the National Government for assistance, Secretary Tracy will this year ask Congress to increase from $25,000 to $50,000 the amount appropriated for the equipment of the State naval reserves.

RECENT ARMOR TESTS.

At the recent tests of 14-in. Bethlehem steel plates at the Indian Head proving ground, shots were fired by the 10-in. gun, as provided by the contract, and all the heavy projectiles rebounded, being unable to perforate the plate. The projectiles were all driven back, but while the Holtzer shells suffered from the impact, the Carpenter shells, made in this country, came out in good shape and carried off the laurels from their foreign competitors. This test of 14-in. armor, like the preceding one, shows better results than could have been hoped for a few years ago. Great interest will attach to the approaching trial of the 17-in. turret armor of the battle ships. Against this a 12-in. gun will be used, three shots being fired, with a striking velocity of 1,332 ft. per second.

THE ENGINES OF THE "BROOKLYN."

The Bureau of Steam Engineering has completed the designs for the machinery of the new armored cruiser *Brooklyn*, the sister ship of the *New York*. Although somewhat similar to the machinery of the *New York*, the designs for the *Brooklyn* are in many respects an improvement over the former vessel.

The designs call for four sets of propelling engines, placed in four water-tight compartments, separated by bulkheads. There will be two sets of engines on each shaft. The crank shafts of the two sets of engines for each propeller are so arranged that by means of an easily operated coupling the forward set may be quickly and easily connected with or disconnected from the after one at will. For ordinary cruising the after set attached to each shaft will be used. The engines will be of the vertical, inverted, direct-acting, triple-expansion type, each with a high-pressure cylinder 32 in.; an intermediate-pressure cylinder 47 in., and a low-pressure cylinder 72 in. in diameter, the stroke of all pistons being 42 in.

It is estimated that the collective indicated horse-power of propelling, air-pump and circulating-pump engines should be about 16,000 when the main engines are making about 129 revolutions per minute. The high-pressure cylinder of each engine will be forward and the low-pressure cylinder aft. The crank-shafts will be made in three sections. All shafting will be hollow. There will be one condenser for each propelling engine. Each main con-

denser will have a cooling surface of about 5,681 sq. ft., measured on the outside of the tubes, the water passing through the tubes. For each set of propelling engines there will be two independent double-acting horizontal air pumps, each worked by a single horizontal steam cylinder.

The main circulating pumps will be of the centrifugal type, one for each condenser, worked independently. Each after engine-room will have an auxiliary condenser of sufficient capacity for one-half the auxiliary machinery, each condenser being connected with all the auxiliary machinery. Each of these condensers will have a combined air and circulating pump.

There will be five double-ended main and two single-ended boilers (to be used as main or auxiliary boilers) of the horizontal return fire tube type, all to be made of steel. All the boilers will be 16 ft. 3 in. outside diameter. Four of the double-ended boilers will be about 18 ft. long, and one will be 19 ft. 11½ in. long. The two single-ended boilers will be 9 ft. 4½ in. in length, all constructed for a working pressure of 160 lbs. to the square inch. The boilers will be placed in three water-tight compartments, each compartment containing two athwartship fire-rooms. Two double-ended boilers will be placed in the forward and two in the after compartment. In the middle compartment the larger double-ended boiler will be placed on the port side and two single-ended boilers will be placed back to back on the starboard side. Each of the double-ended boilers will have eight corrugated furnace flues, 3 ft. 4 in. internal diameter.

The total heating surface for all the boilers will be about 33,353 sq. ft., measured on the outer surface of the tubes, and the grate surface 1,016 sq. ft. There will be three smoke pipes, each 100 ft. high above grate of lower furnace. The forced draft system will consist of two blowers for each fire-room, the blowers discharging into an air-tight fire-room.

IRRIGATION IN INDIA.

(Translated from *Mémoire* by Chief Engineer Barois, in *Les Annales des Ponts et Chaussées*.)

(*Continued from page* 515.)

IV.—SOME NOTABLE DAMS.

BELOW are given, as examples and in explanation of the general remarks before made, condensed descriptions of some of the more remarkable dams which have been built in India.

1. *The Myapore Dam.*—This dam, which is shown in fig. 1,* on the accompanying sheet, is on a branch of the Ganges, at the head of the Upper Ganges Canal. It is 516 ft. in length. At the center there are 15 openings, each 10 ft. in width, separated by piers 3 ft. 6 in. thick, raised 7 ft. 10 in. above the face, which corresponds with the level of ordinary low water. The piers have grooves for sliding gates, but the openings can also be closed by gates turning around a horizontal axis placed below. After the dam was built the number of openings was increased to facilitate the regulation of the water. On both sides of this section with openings the dam is formed by a crest or overfall of masonry, which rises by steps from the center of the river to the banks, where it reaches the height of 10 ft. above the central overflow. In low water the crest of these wing-dams, the width of which varies from 7 ft. to 10 ft., is joined to the central piers by a foot-bridge of planks.

The face has a total width of 34⅔ ft.; it is composed of solid masonry 5 ft. thick between the piers and 3 ft. thick below the piers. At the ends, above and below, are wings 6 ft. high above the face. The bed of the river is formed of coarse gravel and stones. This work is one of the earliest of the modern dams, dating back nearly 40 years.

Among other dams built on river-beds of a similar kind and in the same part of the country are the Ravi Dam, at the head of the Bari-Doab Canal, and the dam across the Jumna at the head of the Eastern and Western Jumna Canals. These two dams are of almost the same type; they are fixed dams, the first 5 ft. and the second 6 ft. in height, with openings near the end. On the Jumna the face of these openings, to increase the force of the flow, is 3 ft. above the opening into the canal.

2. *The Narora Dam.*—This dam, which is shown in figs. 2 and 3, is comparatively a recent work, having been built in 1875-80. It includes a fixed section 3,700 ft. long, and a section 426 ft. long, with movable gates. The dam is at the head of the Lower Ganges Canal.

The section with gates is at one end near the head of the canal. It is composed of 42 arches having a span of 7 ft., carried on piers 40 in. thick, 20 ft. 9 in. high and 30 ft. long.

The face is 3 ft. below low-water mark. The openings are closed by iron gates sliding in grooves made in the piers, and worked by windlasses placed on a masonry bridge 39 ft. above the floor or face. Fig. 3 is a section through one of the openings. The foundation consists of a mass of masonry resting on brick wells sunk in the river bed.

The chief part of the work is the fixed dam, which is of brick, topped with cut stone. It is 10 ft. high, 7 ft. wide on top and 8 ft. at the base; the lower face is vertical and is protected by riprap, as shown in fig. 2. The dam rests on a foundation or bed of cut stone masonry. This extends for 40 ft. above the dam and rests on a row of brick wells from 20 to 25 ft. deep. To present a more complete barrier to leakage through the sandy bed of the river the intervals between the wells are filled by rows of piles, the spaces between the rows being filled with concrete, forming a complete screen. Transverse rows of wells assist in supporting the dam. Above the foundation riprap is extended for 100 ft.; this is cut by two parallel masonry walls about 5 × 5 ft., the object of which is to hold the stones in place against the force of the current.

3. *The Okla Dam.*—This dam, a section of which is shown in fig. 4, is on the Jumna, eight miles from Delhi, at the head of the Agra Canal; it was finished in 1874.

This is a fixed dam, with openings close to the right bank of the river, and is 2,440 ft. long. It has no foundation, resting directly on the river bed, which here consists of a fine sand which packs down very hard. Before building the dam the bed was leveled off. It is a comparatively simple structure, consisting of two parallel walls of masonry 9 ft. high and 4 ft. wide placed 26 ft. apart. The space between these walls is filled in with stone, and an immense mass of loose stone is piled around them, extending some 180 ft. above the dam and 40 ft. below it. A wall of masonry 4 × 5 ft. extends across the river about 40 ft. above the upper wall of the dam, its object being to prevent too great a movement of the stones.

At this point the level of high water is on an average 11 ft. above that of low water, and the current attains a speed of 7 to 8 ft. per second. Notwithstanding the rapidity of the current and the fact that at seasons of flood the dam holds back about four-sevenths of the entire cross-section of the river, it has stood remarkably well.

4. *The Dehri Dam.*—This dam was built about 1875 on the Soane, a tributary of the Ganges. It is of the same type as the Okla dam, and is remarkable for its great length, 12,460 ft. The Soane, the valley of which has an area of nearly 2,350 square miles, has at the point where the dam is built a fall of about 2.64 ft. to the mile, with a maximum velocity of current in flood seasons of 11½ ft. per second; the difference of level between high and low water being 16 ft. The river-bed is of coarse sand and pebbles.

The dam is composed of three parallel walls of unequal heights 33 ft. apart. The foundations consist of masonry wells of quadrangular form sunk 10 ft. below the level of the river-bed. The crest of the dam is 9 ft. above low water. The spaces between these walls are filled in with loose stone and riprap is carried for some 45 ft. above the upper wall and 30 ft. below the highest one. A floor or bed of masonry extends about 18 ft. back of the highest wall. The surface of the dam has a slope of 1 to 2 above the crest and of 1 in 10 below it.

There are three openings in the dam, one near each bank and one in the center. A canal starts from the river

* The figures in the text have been reduced to feet and inches, but in the engravings they are given in meters.

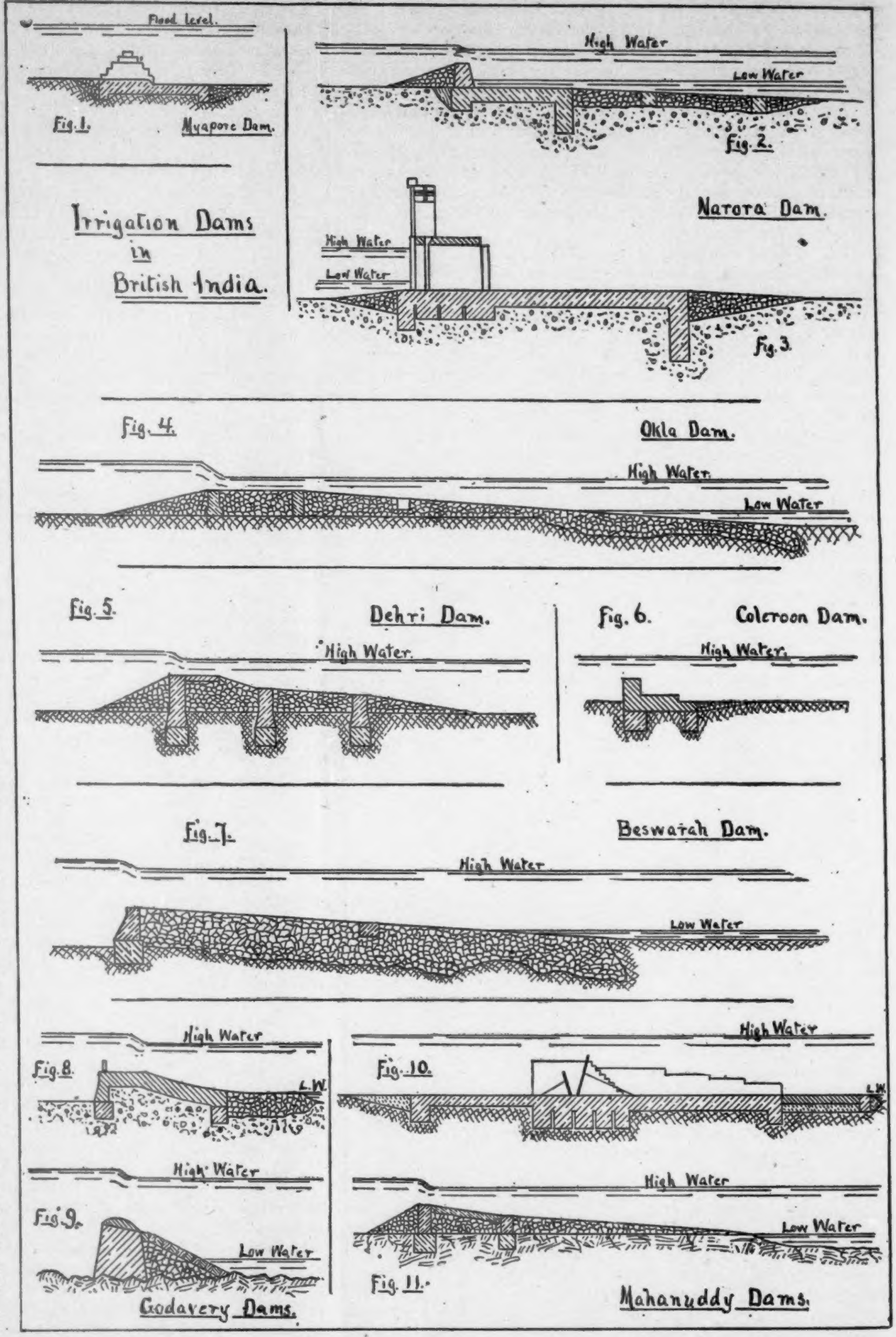
on each side. These openings are each about 500 ft. in length and are divided into spans of 20 ft. They are closed by gates similar to those of a Chanoine dam. Above these gates are fenders pivoted on horizontal axes, and so arranged that they are kept up by the force of the current. These form a screen behind which the gates are worked.

These flood openings are floored with masonry resting on rows of brick wells sunk in the river-bed. The spaces between the wells were dredged out and then filled in with concrete.

The Roopur Dam, on the Sutlej, at the head of the Sirhind Canal in the Punjab, is a work of a very similar type.

5. *The Coleroon Dam.*—This is an old dam, dating from 1834, and is on a branch of the Cauvery River, near the head of its delta. Its object is to throw back into the main stream of the Cauvery the water which would otherwise pass into the Coleroon branch. It is of much use in the system of works for the irrigation of the delta.

The dam consists of a masonry wall, of the section shown in fig. 6, rising 7 ft. above the river-bed at the highest point, and sunk about 3 ft. below it. The foundation consists of a double row of brick wells only 5½ ft. in depth. The masonry extends back from the main wall 22 ft. in the form of an apron, and beyond this there are 9 ft. of riprap. The river-bed is of fine sand.



While this dam cuts off the current of the Coleroon entirely in low water, it has little effect in floods rising 10 ft. above low-water level.

6. *The Beswarah Dam.*—This dam is on the Kistna, about 60 miles from its mouth and near the head of the delta, at a point where the river is shut in two ranges of hills about 4,000 ft. apart. The depth of the river varies from 5 to 6 ft. in the dry season and to 30 and sometimes 40 ft. during the monsoons.

The dam consists of a mass of loose stone rising to a height of 23 ft. above the lowest point of the bed and 14 ft. above low-water level. The dam is in all 3,750 ft. long and 200 ft. in width. At the upper end the mass of riprap is held in place by a brick wall of the section shown in fig. 7. This wall is 12 ft. high and has a crown of cut stone 6 ft. wide. It rests on a foundation consisting of a double row of brick wells sunk 7 or 8 ft. into the alluvium which forms the bed of the river. A light wall extending across 90 ft. below the main wall serves to hold the stone in place against the action of the current. The stones on the surface of the dam are very large, many of them weighing 2 tons each.

At each end of the dam there is an opening, the object of which is to scour out the bed at the heads of the two canals which start, one on each bank. Each opening con-

sists of 15 arches of 6 ft. span, and these are closed by sliding gates. The entire masonry is covered at high water.

7. *The Godavery Dams.*—The first of these is a comparatively simple work, consisting of a masonry wall of the section shown in fig. 9, founded directly on the rocky bed of the river. This wall is of rough stone and is protected below by riprap. It is 5,250 ft. in length and has an average height of 15 ft. At its greatest height—25 ft.—this wall is 23 ft. thick at the base and 17 ft. at the top ; the thickness decreases to 13 and 10 ft. where the wall is 15 ft. high. The extreme rise of the river in floods is about 40 ft.

The most important work on the Godavery is at the head of the delta, about 30 miles from the sea. Here the Godavery, which has a valley covering about 100,000 square miles, and which rises about 30 ft. in floods, has a total width of 3½ miles, divided by islands into four channels. The dam is extended in a straight line across the entire width of the river by works of various kinds—earth dikes and riprap dams pierced at intervals by openings with movable gates, and finally by a masonry dam. The total length of the masonry is about 2.4 miles. The river-bed is of sand extending to a great depth.

The fixed masonry dam consists of a revetment of masonry covering a bank of sand carefully rammed down. The crest is 12 ft. above the river-bed. This revetment consists of a vertical wall 12 ft. high, then a horizontal face 18 ft. wide, and finally a slope, slightly concaved and 25 ft. in width. The foot of this slope is protected by riprap. At each end of the masonry is a row of brick wells forming a foundation. This work is shown in section in fig. 8.

On the crest of the dam are placed movable gates or flash-boards, which can increase the height of the dam 2½ ft. when it is desired to hold back the water.

At the season of the highest flood this dam holds back about two-sevenths of the cross-section of the river.

8. *The Mahanuddy Dams.*—At the head of the Mahanuddy delta there are three distinct works. The first is the Naraji Dam built across the Katjori arm of the river, and intended to divert its waters to the two principal branches. This is a vertical wall rising 10 ft. above low-water level and extending across the river in an oblique direction. It is founded on an old bed of riprap which at some unknown period had been thrown into the sandy bed of the river. It is protected below from the current by stone carefully selected and piled up. This dam is 3,600 ft. long. The river rises here at times to a height of 30 ft., and its delivery in flood is estimated at 700,000 cub. ft. per second. The location of this dam in a line oblique to the current is recognized as a source of weakness, as it causes dangerous eddies which are liable to scour the foundations. The only opening is near the right bank, and permits a sufficient amount of water to pass to supply the city of Cuttack.

The second dam is 1,970 ft. long, crossing the Beropa arm of the river. It is similar to the third—described below—and has two series of openings closed by Chanoine gates. It is 9 ft. in height. At each end is the head of a canal. The river-bed is of sand, except for a short distance, where it is rock.

The third dam, known as the Cuttack Dam, is 6,350 ft. long, and rises to a height of 12 ft. above low water. It is of a type similar to the Dehri Dam, consisting of parallel walls 30 ft. apart, the space between filled in with stone. Above the upper and below the lower wall are masses of riprap. The walls are founded on rows of cylindrical brick wells. For part of the length of the dam there are three parallel walls ; the rest of the distance there are two only, as shown by the section in fig. 11. At the dam the river-bed is of sand, and the average rise in floods is 22 ft. above low water.

Near each end is a row of openings, and at the center is an opening of 500 ft. divided into 10 spans of 50 ft. each. These are closed by Chanoine gates provided with fenders ; a section through one of the openings is shown in fig. 10.

The three Orissa canals start from this dam, and from them the entire delta is irrigated. The three dams of the Mahanuddy have been the most expensive works of the kind in India, and their maintenance expenses yearly are about 1 per cent. of the first cost.

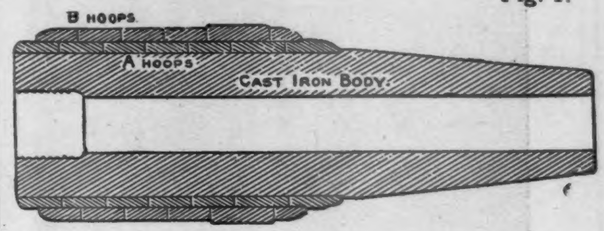
(TO BE CONTINUED.)

THE NEW BREECH-LOADING MORTARS.

SOME reference has been made from time to time to the new rifled mortars which hold an important part in the plans for the new system of coast defense. Contracts were made for 73 of these guns, to be 12 in. caliber, cast-iron body, steel-hooped and weighing 14¼ tons each. At the present time 37 of these have been delivered, and work on the others is in progress. The contract was let to the Builders' Iron Foundry, Providence, R. I., and to a handsome pamphlet issued by that company we are indebted for the facts given in this article.

The mortars in appearance very closely resemble the steel breech-loading rifles made by the United States Navy

Fig. 1.



Department, with the exception of their length, which in the rifles is about 30 times the diameter of the bore, and in the mortars only 10 times.

The cast-iron bodies have a 12-in. bore, are 129 in. long and 31½ in. diameter, and the diameter over the steel hoops, which are shrunk on the bodies in two rows, as shown in the accompanying sketch, is 42½ in.

The specifications in the contract call for the castings for the bodies to be made from charcoal pig, and to be cast vertically, breech downward ; to be cooled by the circulation of water through the core, according to the Rodman process. Test specimens cut from both muzzle and breech ends of the mortar to have an elastic limit of about 17,000 lbs. and a tensile strength between 30,000 and 37,000 lbs. per square inch, or nearly double the strength of ordinary cast iron ; one-fifth of the entire casting to be cut off for a shrink or sinking-head.

The metal is also tested for specific gravity and hardness. The latter is a comparative test, and is made by forcing a standard steel pyramid into the metal and noting the depth to which it sinks under a given pressure.

The metal is melted in what is known as an air furnace, and the casting and cooling operations are conducted with the greatest care.

When ready the casting is placed in a gun lathe, which is of heavy build with a long boring-bar attachment instead of a tail-stock. The gun is held and driven by a large chuck on the face-plate, and the other end of the casting runs in a semicircular bearing or steady rest. The boring-bar has no rotary movement, but is fed toward the face-plate and carries a reamer-like cutter-head which enlarges the hole by several cuts to 11.8 in. Meanwhile, ordinary turning tools are turning down the chase or forward taper and parting off the test disks and shrink head. The parting tools are run in nearly to the bore, the gun body is removed from the lathe and the disks broken from the casting by wedge and sledge. The hole is next enlarged to within 0.1 in. of the final diameter.

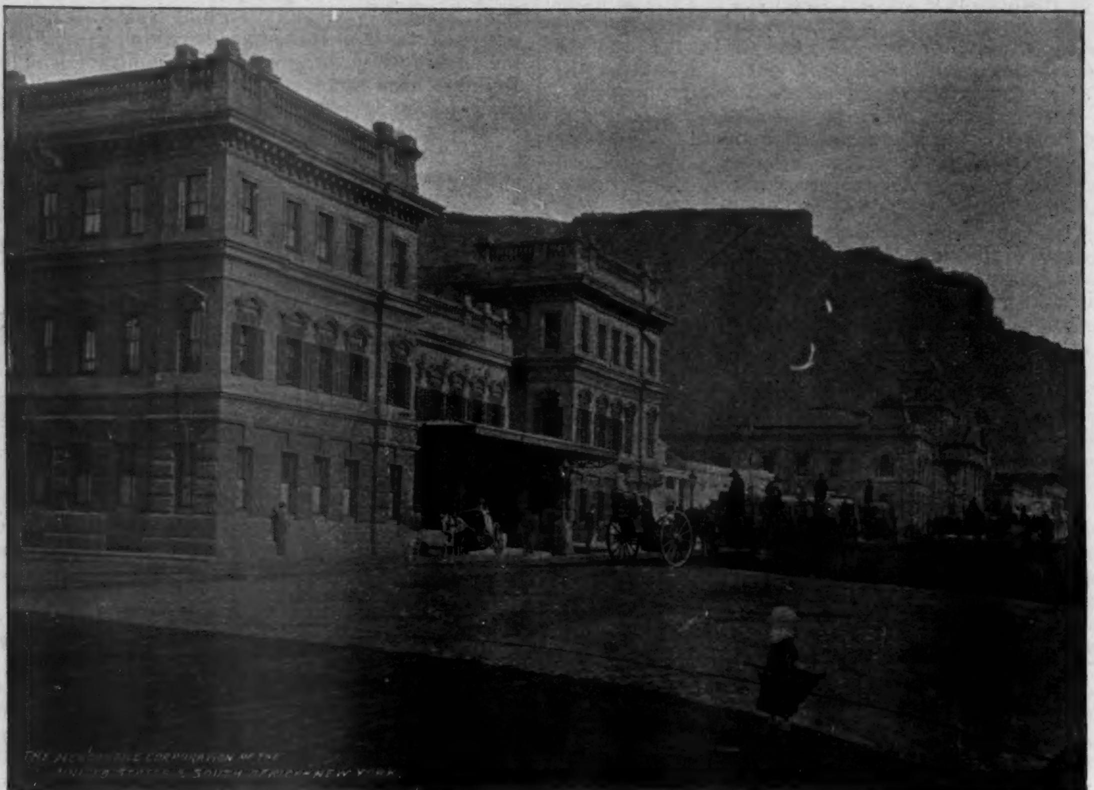
The steel hoops preparatory to shrinking are faced at the ends and bored to 31.5 in. diameter, 0.003 being the allowed variation from exact size.

The outside of the body is now accurately turned to a varying diameter slightly larger than the inside of the hoops to be shrunk thereon. This difference is called the "shrinkage," and it varies along the entire length to be hooped, the purpose being to place each of the hoops under nearly equal tension. As might be supposed, the diameter of the bore is slightly decreased when the hoops are shrunk on.

The hoops are heated in a gas furnace, are slipped over the body and up to their proper place, a pressure of 100

tons being used to make a tight joint between each hoop and the one next to it. They are gradually cooled by a stream of water, which is brought to bear first on the forward end of the hoop and then moved slowly backward. There are two tiers of hoops, as shown in the section.

then swung round out of the way. The shot is raised by a crane and shoved in, and the powder follows in a bag. The tray is then swung back to its first position and the breech-block is run in by turning the translating roller-crank handle, and locked by the revolving gear handle.



RAILROAD STATION AT CAPE TOWN, SOUTH AFRICA.

The next step is the fine boring, which must be within 12 000 and 12.003 in. diameter, and straight enough to allow a test cylinder 11.997 in. in diameter and 42 in. long to slip easily through the bore.

The next operation is the rifling, which requires the greatest care and exactness. In this rifling 68 grooves are cut, 0.379 in. wide and 0 07 in. deep, and these grooves

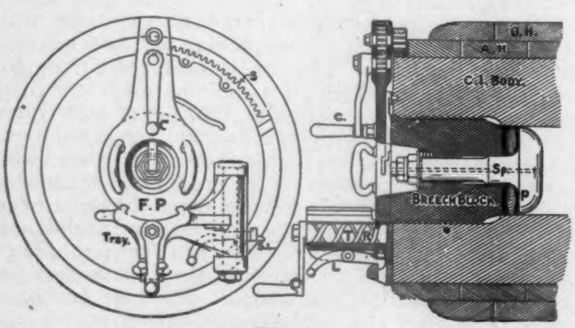


Fig. 2.

have an "increased pitch" varying from one turn in 25 caliber to one in 40: the object being to avoid a too sudden initial rotation of the shot when fired. The next operation is the threading for the breech-block which is done with a special machine.

The breech mechanism is shown in the second sketch, and is of the pattern adopted by the Ordnance Bureau. It will be readily understood from the drawing. To load, the breech-block is unlocked by turning the crank *C* to the right; the roller-crank is then turned, pulling out the breech-block and connecting parts upon the tray, which is This uncovers the vent, where a primer is inserted, and the mortar is ready to aim and fire.

In these mortars about 80 lbs. of powder will produce an initial pressure of some 28,000 lbs. per square inch, and give a muzzle velocity of 1,200 ft. per second to a shell of 830 lbs. This will insure a range of about six miles at 45° elevation. The shell or hollow steel shot contains about 30 lbs. of fine powder. Its front end is turned to an ogival curve, a form which offers the least resistance to the air, and its back end contains a soft metal collar which, when forced into the rifling grooves, gives it the required rotary motion. The primer is placed in the back end of the shell; it does not move from its place when the shot is fired, but is projected forward against a fulminating cap when the shell strikes any object.

These mortars are to be mounted on carriages very similar to cannon carriages, except that the recoil takes place 50° from the horizontal plane instead of in that plane.

In the plans for coast defense it is proposed to place these mortars at the points selected in groups of 16, protected from the fire of an enemy's ships by high earth embankments; there will be appliances for firing the group simultaneously by electricity.

SOUTH AFRICAN RAILROADS.

THE gradual growth of the English colonies in South Africa has not attracted much attention in this country, and few people appreciate the fact that a very considerable railroad system has been built up in that country. While the gold and diamond mines have done something toward populating South Africa, the larger part of its growth has had the more solid basis of agricultural settlement and development.

The railroads of South Africa have been built and are operated by the local governments, and their rates are entirely under State control. The uniform gauge is 3 ft. 6 in., and the material and rolling stock have been supplied from England. It would seem that there might be an opportunity here for the introduction of American methods and appliances, which are best adapted to a new country.

The sketch map given herewith shows in outline the existing railroad system. The other illustration is from a photograph of the railroad station in Cape Town, a solid and handsome building.

The railroad system of South Africa includes five principal lines, each having a terminus at some coast port. These lines may be briefly described as follows :

1. From Cape Town a main line is now completed north by east to Vryburg, in Bechuana Land, a distance of 775 miles. An extension of 200 miles to Medeking is in progress, and the road is intended to reach finally the Tati gold-fields in Matabeleland. This line carries the traffic of the northern part of Cape Colony, the western sections of the Orange Free State and the Transvaal and the eastern part of Bechuana Land. It has already attracted much business from the far interior.

From Cape Town also there are several short local lines, while on the west coas- there is a short line to Springbokfont tein.

2. From Port Elizabeth a line runs first north and then north by east to Bloemfontein, the capital of the Orange Free State, and thence to Johannesberg in the Transvaal, 662 miles from Port Elizabeth ; an extension of 100 miles to Pretoria is nearly finished. A branch from Middelberg connects this line with the Cape Town-Vryburg line at De Aar. This line has a traffic very similar to the first one, including not only agricultural products and cattle, but the business of the great mining districts.

A purely agricultural line runs from Port Elizabeth northwest 200 miles to Graaf Reinet, the center of the most prosperous district in the colony. There are also some short branch lines.

3. From East London a line about 290 miles long runs northward to Aliwal. This line also has a traffic entirely agricultural.

4. From Durban, on the east coast, a line is completed northward about 180 miles to Newcastle, where there is coal of good quality, already worked to a considerable extent. This is said to be the most profitable of all the lines. A branch runs from this line westward 80 miles into the Orange Free State.

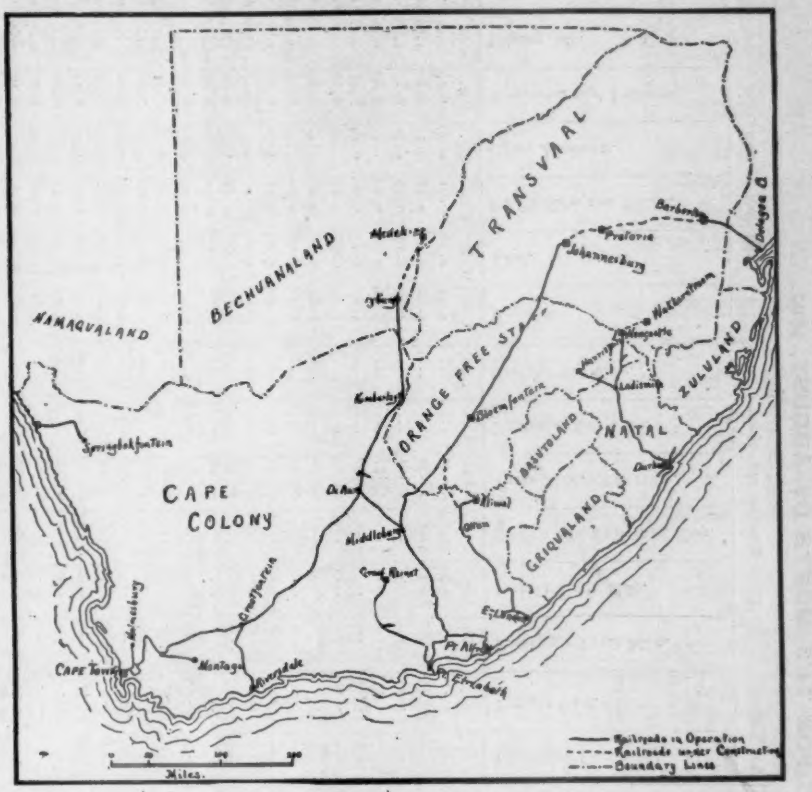
There are also two short lines from Durban, each about 25 miles long, serving the sugar and coffee districts along the coast.

Extensions from Newcastle to Wakkerstroom and Pretoria in the Transvaal are in progress.

5. From Delagoa Bay a line is completed west about 140 miles to the Barberton and Fontspanberg gold districts and is under construction 180 miles further to Pretoria. This line has been an expensive one to build, running for nearly all its length through a rough and mountainous country. It will, however, be very much the shortest outlet to the sea for the Transvaal, which many consider the richest part of South Africa. It is not proposed to stop at Pretoria, the intention being to build at least 300 miles beyond that place into the interior.

6. Still further north—not shown on the map—work has been begun on a line from the Pungwe River inland 300 miles to Fort Salisbury. This is not in the limits of any of the South African States, but is controlled by the British East African Company. When finished it is expected to carry the traffic of Matabeleland and Mashonaland, regions which are but little settled as yet.

It will be seen that the South African system is as yet only an outline, and that there is much to be done in filling it in, building branches and secondary lines as the country fills up. The rivers are not factors in the transportation problem in that country ; in the rainy season they are rapid torrents, but in the dry season they have no water. Even the largest rivers, such as the Orange and



SOUTH AFRICAN RAILROADS.

the Vaal, are not navigable. In fact, the lack of water is the greatest drawback to the prosperity of the country.

For much of the information given above we are indebted to Dr. Aurel Schultz, of South Africa, and to Messrs. Haase & Vaughan, the representatives of the Mercantile Corporation of the United States and South Africa, an organization lately formed to promote trade between the countries, which has a large field to work in.

Some Compound Locomotive Patents.

LINDNER'S STARTING-VALVE.

FIGS. 8–17 show an improved form of starting-valve, for which patent No. 481,181 has been issued to Robert Lindner, of Chemnitz, Germany. This is a modification of the valve which has been in use for some time on the Saxon State Railroads, of which Mr. Lindner is Chief Engineer, and on other roads in Europe. His description is as follows :

"In a starting-gear patented to me in various countries I used to combine the starting-cock or valve V with the receiver $C\ C$ by a pipe f^4. In the present invention, however, the plug of this valve V is connected to the starting-lever by a lever g and a rod K. By the full throw of the reversing-lever from one extreme position to the other it is moved through an angle of 90°, so that when the lever is in its forward position the port n is in communication with the steam pipe f', leading to the regulator-valve, and the port m in communication with the pipe f^4, leading to the low-pressure slide-valve. When the lever is in its backward position, the communication is the same, the port m having the same position as n in the first case, and *vice versa*. In any intermediate position of the reversing-lever the valve V is closed. The steam is admitted from the pipe f^4 to the low-pressure cylinder B through the port Z'.

LOCOMOTIVE RETURNS FOR THE MONTH OF AUGUST, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Locomotive Mileage. Freight Trains.	Locomotive Mileage. Service and Switching.	Locomotive Mileage. Total.	Locomotive Mileage. Average per Engine.	Av. Train. Passenger Cars.	Av. Train. Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Coal Burned per Mile. Freight Train Mile.	Coal Burned per Mile. Service and Switching Mile.	Coal Burned per Mile. Train Mile, all Service.	Coal Burned per Mile. Passenger Car Mile.	Coal Burned per Mile. Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Cost per Locomotive Mile. Fuel.	Cost per Locomotive Mile. Oil, Tallow and Waste.	Cost per Locomotive Mile. Other Accounts.	Cost per Locomotive Mile. Engineers and Firemen.	Cost per Locomotive Mile. Wiping, etc.	Cost per Locomotive Mile. Total.	Cost per Car Mile. Passenger.	Cost per Car Mile. Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	....	55	38,949	77,748	37,708	154,405	2,807	....	....	62.30	84.39	51.54	69.44	....	...	4.30	4.30	0.31	0.50	6.20	2.00	17.61	....	....	....
Alabama & Vicksburg	....	17	18,370	14,041	11,252	43,663	2,569	....	....	45.87	83.33	41.67	58.31	....	....	3.20	4.90	0.27	0.70	6.20	1.80	19.07	....	....	....
Atchison, Topeka & Santa Fé	834	739	....	....	378,487	2,327,080	3,149	....	....	...	....	....	77.61	....	....	4.89	6.24	0.29	0.12	6.61	1.38	19.53	....	. ..	1.56
Canadian Pacific	598	....	508,050	731,516	482,863	1,722,429	2,880	. ..	....	....	....	....	58.77	....	....	3.54	9.98	0.40	....	5.23	1.30	20.45	....	1.75	3.22
Chic., Burlington & Quincy	517	....	....	....	....	1,902,765	3,680	5.70	18.84	....	....	....	75.90	....	....	4.80	4.92	0.20	0.19	6.57	....	16.68	....	...	1.30
Chic., Milwaukee & St. Paul	806	....	....	....	....	2,707,443	3,359	....	....	....	....	....	64.60	....	....	3.54	6.61	0.28	....	6.86	....	17.29	....	....	2.00
Chic., Rock Island & Pacific	552	....	684,681	1,012,386	408,659	2,105,726	3,815	....	....	52.62	70.55	38.22	57.92	....	....	2.61	5.44	0.27	....	5.99	0.38	14.69	....	....	2.00
Chicago & Northwestern	871	....	734,489	1,414,029	861,966	3,010,484	3,456	....	....	....	....	....	75.30	....	....	3.38	7.01	0.36	....	6.34	0.80	17.89	.. .	....	1.84
Cincinnati Southern	....	97	34,826	164,027	82,353	331,206	3,415	....	....	60.81	112.36	36.90	81.63	....	....	4.40	4.70	0.28	1.30	6.50	1.80	18.98	....	....	....
Cumberland & Penn*	23	22	5,479	33,345	....	38,824	1,765	....	....	....	....	....	81.30	....	....	6.12	4.50	0.40	....	....	1.70	12.72	....	....	....
Delaware, Lackawanna & W. Main L.	208	192	....	....	....	674,377	3,512	....	....	....	....	....	73.56	....	....	3.17	5.66	0.43	...	5.63	....	14.89	....	....	....
Morris & Essex Division	157	....	176,683	240,721	13,333	430,737	2,745	....	....	.. .	....	....	59.26	....	....	4.05	9.18	0.42	....	6.08	...	19.73	....	....	3.08
Hannibal & St. Joseph	....	70	76,677	172,180	37,838	286,695	4,096	5.55	17.30	....	....	....	76.83	11.03	5.36	9.16	5.26	0.19	0.13	6.18	....	20.92	....	....	....
Kan. City, F. S. & Mem.	143	....	104,529	226,514	109,216	440,259	3,078	....	....	....	....	....	58.17	....	...	3.78	4.63	0.32	0.36	7.30	....	16.39	....	....	1.54
Kan. City, Mem. & Birm.	41	38	37,107	52,971	18,060	108,138	2,846	....	....	....	....	....	57.92	....	....	3.86	3.41	0.25	0.37	7.21	....	15.10	....	....	1.13
Kan. City, St. Jo. & Council Bluffs	43	42	62,843	49,661	51,006	163,510	3,803	5.07	21.53	...	....	....	58.52	11.18	4.49	4.16	5.05	0.12	0.08	5.72	....	15.13	....	....	1.80
Lake Shore & Mich. Southern	587	....	448,981	696,696	613,518	1,759,195	2,996	....	....	55.02	79.45	31.82	57.11	....	....	3.10	4.47	0.12	0.04	6.99	0.21	14.93	....	....	1.56
Louisville & Nashville	....	†341	450,957	798,967	416,815	1,666,739	3,665	5.12	16.12	60.24	104.37	56.80	76.70	11.84	6.26	4.19	6.28	0.27	1.41	6.11	0.60	18.86	3.17	1.45	1.63
Manhattan Elevated	....	273	767,011	....	52,135	819,146	3,001	....	....	....	....	....	40.57	....	....	2.90	8.10	0.30	....	8.70	....	20.00	....	....	3.99
Mexican Central‡	146	116	....	....	....	395,418	3,409	....	....	...	....	....	67.80	....	....	4.74	13.62	0.46	0.19	5.47	0.80	25.28	....	....	4.82
Mil., L. S. & Western	112	....	84,437	184,633	117,344	386,414	3,450	....	....	....	....	....	67.14	....	....	2.81	9.21	0.25	....	6.10	0.86	19.23	....	....	2.75
Minn., St. P. & Sault Ste. Marie	....	....	68,991	137,652	60,762	267,405	....	4.88	18.82	....	....	....	61.86	....	....	3.33	10.28	0.19	....	6.39	....	20.19	...	1.63	3.31
Missouri Pacific	339	308	....	....	....	1,254,630	4,076	4.78	17.17	....	....	....	79.33	13.25	5.76	4.49	5.77	0.39	1.10	6.41	1.34	19.50	3.82	1.32	1.43
N. O. & Northeastern	.. .	33	30,676	44,228	24,465	99,369	3,011	....	....	64.52	100.00	34.01	73.26	....	....	5.60	6.20	0.32	0.50	6.30	1.70	20.62	....	...	....
N. Y., Lake Erie & Western	....	618	478,335	917,867	292,409	1,688,611	2,732	4.90	21.70	83.70	120.40	60.60	....	17.00	5.60	5.18	6.62	0.41	1.85	7.22	1.16	22.44	....	1.70	....
N. Y., Pennsylvania & Ohio	....	257	144,287	439,309	144,116	727,712	2,532	6.20	18.00	76.00	114.70	65.90	....	12.20	6.40	4.55	5.62	0.31	2.38	6.75	1.00	20.61	....	1.70	....
Norfolk & Western, Gen. Eastern Div.*	....	142	102,758	262,280	55,213	421,251	2,964	4.80	20.10	....	...	....	95.68	....	....	8.20	2.90	0.80	....	....	....	11.90	....	....	....
General Western Division*	....	115	63,969	224,391	27,485	315,845	2,739	4.70	15.70	....	....	....	125.00	....	....	12.50	3.60	0.70	....	....	....	16.80	...	....	....
Ohio & Mississippi	113	....	149,146	157,727	92,961	399,834	3,538	....	....	....	....	....	65.06	...	....	3.78	2.84	0.21	0.89	5.40	1.27	14.49	....	....	0.86
Old Colony	232	....	386,829	131,695	127,369	645,893	2,784	....	....	....	....	....	56.35	....	....	2.74	10.57	0.63	....	6.59	0.77	21.30	....	....	3.75
Philadelphia & Reading	....	....	497,818	623,710	548,723	1,770,251	....	....	....	....	....	....	73.58	....	....	4.59	4.10	0.32	....	5.72	0.40	15.13	....	....	....
South. Pacific, Pacific System	713	...	....	....	....	1,923,729	2,698	....	....	....	....	....	70.32	....	. ..	5.02	18.35	0.36	1.57	7.38	1.59	34 27	....	...	5.27
Union Pacific	994	....	741,880	1,432,658	477,930	2,652,468	2,668	5.59	17.35	....	....	....	88.53	13.70	6.85	6.96	8.00	0.39	0.73	8.01	1.08	25.17	4.22	1.76	1.80
Vicksburg, S. & P.	....	14	10,858	10,488	9,576	30,922	2,209	....	....	46.84	79.36	28.49	53.05	...	....	6.60	5.90	0.22	1.20	6.70	3.00	23.62	....	....	....
Wabash	401	351	420,558	736,975	289,022	1,446,555	4,124	5.18	18.38	65.70	94.07	49.97	77.01	12.67	5.11	3.07	4.35	0.27	....	6.20	0.80	14.69	2.59	0.91	1.13
Wisconsin Central	150	130	133,013	237,049	77,339	447,401	3,442	....	....	....	....	....	73.42	....	....	3.32	9.34	0.29	....	7.16	....	20.11	....	....	2.42

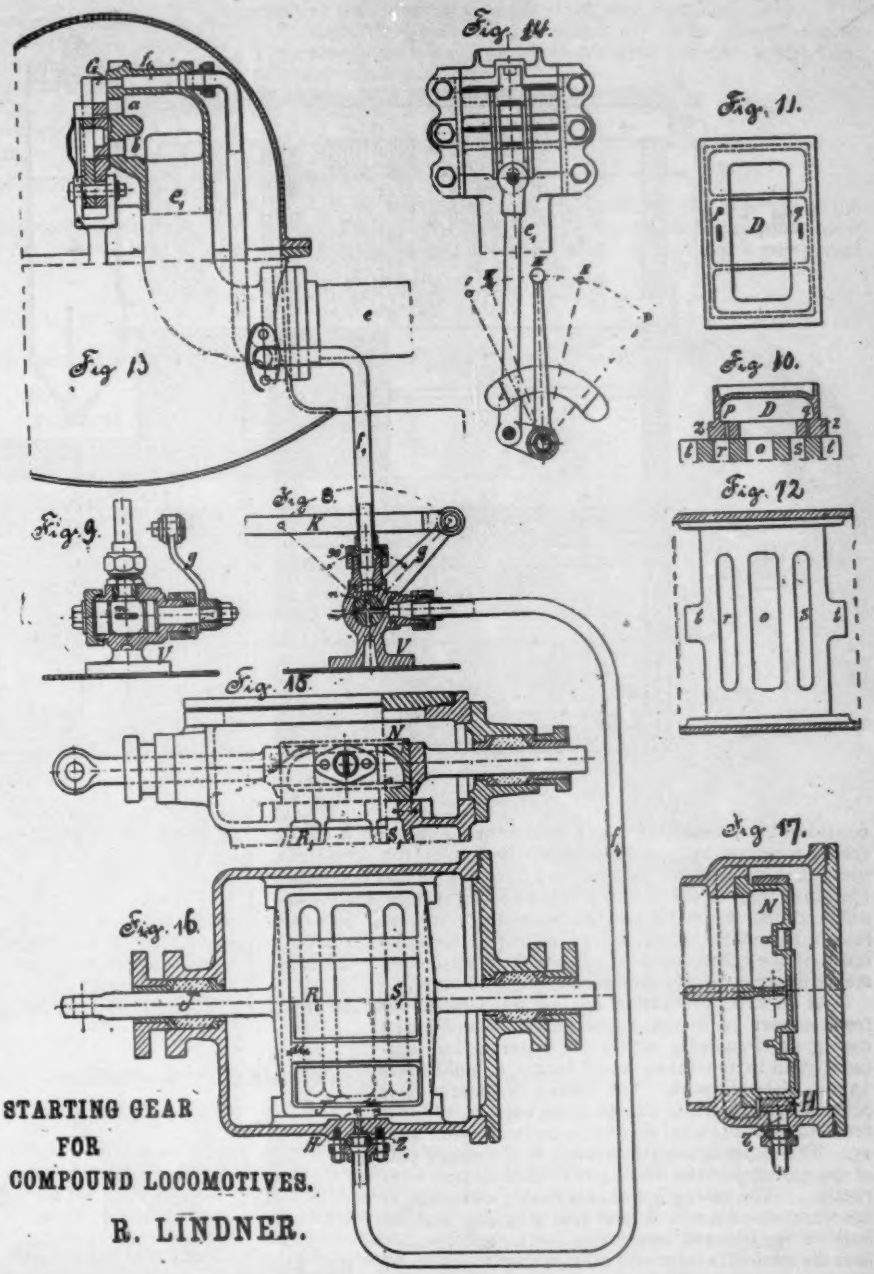
NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Wages of engineers and firemen not included in cost.

† Number of engines in revenue service only ; average mileage is also based on revenue service.

‡ The Mexican Central Railroad reports 19.2 units of work per $1 of expense ; 163.3 units of work per ton of coal ; 12.25 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

"In order to regulate the entrance of steam from the pipe f^1 into the steam-chest of the low-pressure cylinder *B*, attach a slide *H* to the valve-buckle *N*, as shown in fig. 16. This slide *H* is integral with or firmly secured to the low-pressure slide-valve *N*, the valve-rod *J*, or valve-buckle *J*. The latter, as shown, slides on the bottom of the slide-valve case and the slide *H* at or about at middle height of the same. By making the lap *u* of the slide *H* equal to the outside lap *u* of the valve *N*, one of the ports *R'* or *S'* is opened or closed at the same time the port *Z'* opens or closes. When the slide *H* is in its middle positions, which is always the case when not starting by means of the low-pressure cylinder, the port *Z'* is covered, and thus steam is admitted to the low-pressure slide-valve chest only when it can proceed to the low-pressure cylinder by one of the ports *R'* or *S'*. The entrance of steam from the low-pressure valve-chest into the receiver *C* is thus prevented, except when said steam has also admission to the low-pressure cylinder. The amount of steam passing the cock or valve *V* will be regulated by the slide-valve *e'* (illustrated in detail by figs. 13 and 14), and also attached to the engine. The slide of this valve has a lug *G* cast on, which covers or uncovers the port leading into the pipe *f'*. The motion of the slide is regulated by the handle illustrated by fig. 14, which can be moved from one position to the other (indicated by the numbers 1 and 5). At 1 the ports are all closed, and no steam can enter the same. While moving from 2 to 5, the main ports *a* and *b*, leading into the high-pressure pipe *e*, are opened. At the beginning and ending of this opening the port leading into the pipe *f'* will be closed. The opening thereof only takes place while the handle is moved between 3 and 4, and while passing from 4 to 5 the port *f'* will be full open. The steam admitted to the high-pressure cylinder *A* by the steam-pipe *e* exhausts into the low-pressure cylinder *B* through the pipe *C C*, which at the same time serves as a receiver, and the steam of the low-pressure cylinder *B* exhausts into the air or into a condenser. The high-pressure slide-valve *D* is provided with ports *p q* on the exhaust side (see figs. 10 and 11) in order to relieve the high-pressure piston from unequal strain, as the steam has admission to both sides of the same. These ports *p* and *q* place the exhaust-port *o* in communication with the two steam-ports *r* and *s* as soon as the valve *D* shuts off. The bar *z* is either equal to or greater than the breadth of the ports *r* and *s*, so that steam cannot pass from the valve-chest into the exhaust-port *o*, but allows of steam passing from the exhaust-port into the back and front side of the cylinder."



STARTING GEAR FOR COMPOUND LOCOMOTIVES.

R. LINDNER.

Recent Patents.

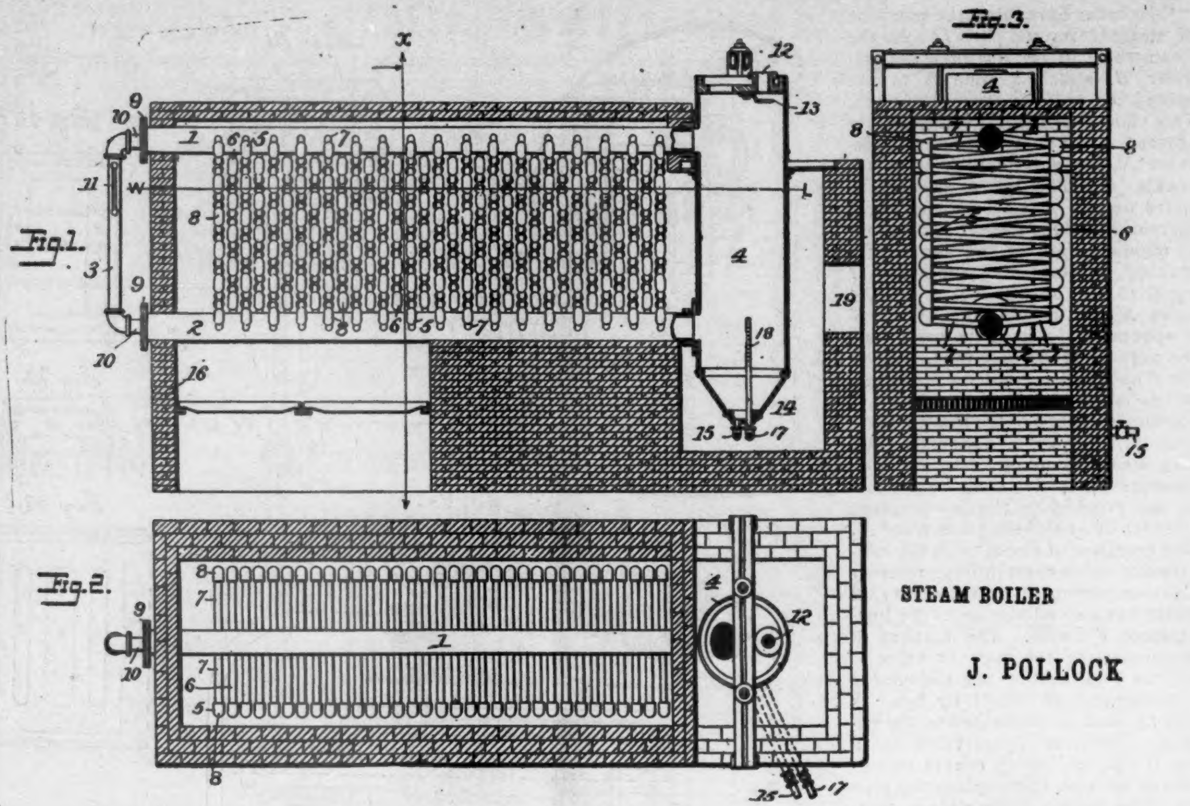
POLLOCK'S WATER-TUBE BOILER.

In figs. 1, 2, and 3 is shown a new form of water-tube boiler, for which patent No. 482,459 was recently issued to James Pollock, of Wilkes-Barre, Pa. Fig. 1 is a side elevation, partly in section; fig. 2 is a plan, and fig. 3 is a cross-section on the line *X X* in fig. 1. The patentee describes his invention as follows:

"The principal parts of the boiler are a horizontal steam-drum 1 at the top and a horizontal water-drum 2 at the bottom, a vertical pipe 3, connecting the forward ends of the drums, a vertical chamber 4, communicating with the rear ends of the drums, and two series of zigzag pipes 5 6, arranged between the drums within the furnace. The zigzag sections or pipes 5 of one series are fitted to one side of the steam-drum and to one side of the water-drum, and the sections 6 of the other series are fitted to the opposite sides of the drums and cross and recross the sections 5 a number of times, thus forming a maze of pipes through which the hot gases from the furnace are compelled to travel. The upper and lower members 7 of the zigzag sections are reversely threaded at their ends and screw into the drums and the return-bends 8. Any section of the zigzag pipes may be quickly removed by simply unscrewing the portions 7 at its top and bottom, and, if necessary, a new coil of pipe may be substituted, the coils being all exactly alike and interchangeable.

"The front ends of the drums are closed by plates 9, bolted to flanges on the drums, and these plates are tapped to receive short pipes 10, to which the vertical pipe 3 is attached. The pipe 3 is tapped above and below the water-line *W L*, to receive the ends of a glass gauge 11 for indicating the level of the water in the boiler.

"As above stated, a great objection to water-tube boilers is that a large amount of moisture in the form of water is carried off with the steam. This is partly due to the fact that a portion of the steam is formed considerably below the water-line, and in passing through the narrow tubes to the steam-drum it necessarily agitates the water violently and tends to carry off a



STEAM BOILER

J. POLLOCK

considerable amount of it. Furthermore, it has been considered necessary heretofore to keep the tubes full of water to prevent them from burning out. I have found that portions of the tubes may be safely and profitably located above the water-line and that the water carried up by the steam will be vaporized in the heated tubes and at the same time keep the temperature of the tubes down to prevent injury to them. Thus the steam is rendered dry and partially superheated.

"As an extra precaution against wet steam I take the steam from a port 12 in the upper part of the enlarged casing or chamber 4, where the water is less agitated than in the tubes, and I locate a baffle-plate 13 opposite said port. The casing or chamber 4 is preferably cylindrical, except at the bottom, where it terminates in a conical section 14 and a blow-off pipe 15. The steam-drum 1 is riveted to the upper part of the casing and the drum 2 is riveted to the lower portion. The casing 4 acts as a setting-chamber, as the water-currents in it are very sluggish and the bulk of the dirt and impurities in the water settle into the conical bottom and may be readily drawn off through the blow-off pipe 15. Should any dirt accumulate in the drums, it can be readily removed by taking off the plates 9 and inserting a suitable flue-cleaner. For this purpose the drums are extended through the front wall 16 of the furnace.

"The feed-water may be introduced into the boiler at any point; but I prefer to connect the feed-pipe 17 to the casing 4 near its lower end and to provide its inner end with a perforated or spray pipe 18. In this way the coolest water in the boiler is always nearest the flue 19, where the gases pass out of the furnace, and in this way the escaping gases are reduced to the lowest possible temperature and the greatest economy obtained."

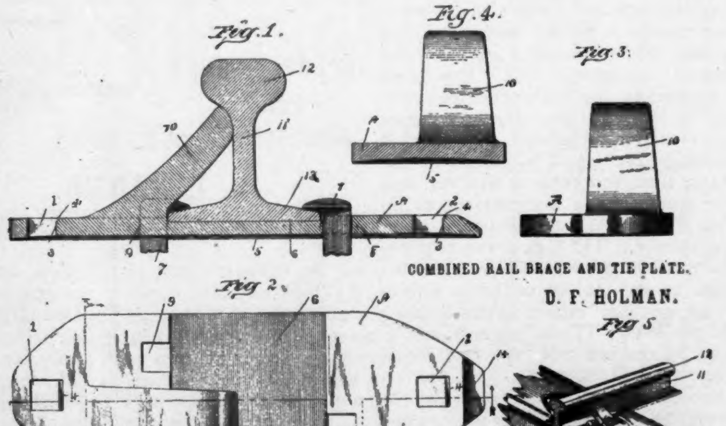
HOLMAN'S RAIL-BRACE AND TIE-PLATE.

The accompanying illustration shows a combined rail-brace and tie-plate, for which patent No. 485,384 was recently issued to Danial F. Holman, of Chicago.

In the drawings fig. 1 is a vertical longitudinal section of a combined tie-plate and rail-brace and a cross-section of a rail secured thereto. Fig. 2 is a top plan view of the tie-plate and rail-brace. Fig. 3 is an end elevation of the same. Fig. 4 is a cross-section on the line 4 4 of fig. 2, and fig. 5 is a perspective view of a portion of a tie and a rail-section secured thereto by a tie-plate and rail-brace constructed in accordance with this invention.

These drawings show the device so plainly that but little description is needed. The under face of the plate is concaved, as shown at 5 in figs. 1 and 4, the result being that the tie-plate will adapt itself to the inequalities in the surface of the tie, and will rest firmly thereon. The edges of the tie-plate will also be embedded to a certain extent in the tie, which provides an additional resistance to the spreading and adds to the strength of the track.

Some of the advantages claimed are stated by the inventor



COMBINED RAIL BRACE AND TIE PLATE.

D. F. HOLMAN.

as follows: "This Invention can also be applied to an old track as well as new tracks, and to facilitate such the end of the tie-plate removed from the arm 10 is sharpened or beveled, as at 14, so that the said tie plate can be easily driven beneath a rail that is already laid. It will be further obvious that to remove a rail secured by my invention it is only necessary to remove one spike in each plate—namely, the inner spike 7, or the one passing through hole 8.

"The combined tie-plate and rail-brace herein described can be made to fit any size rail, and in a track constructed with this invention the rails are strengthened, the ties will last longer, the spikes will act with greater efficiency, and the solidity and stability of the track is materially increased."

Foreign Naval Notes.

SOME interesting trials of torpedoes were recently made in the River Plate. In these the attacking boats were judged to be uniformly successful, and the conclusion reached by the witnesses was that a night attack by a torpedo squadron would be an extremely dangerous affair for a large ship, the chances being altogether on the side of her active enemies.

ARMOR TESTS IN ENGLAND.

Some interesting armor-plate tests were carried out November 1 on board the target vessel *Nettle*, at Portsmouth, England. Messrs. Vickers & Company, Sheffield, were some time ago commissioned by the Government to manufacture a nickel-steel plate and to treat it in accordance with the Harvey process, by which great hardness is communicated to the surface, together with a proportionate amount of toughness, so that the increased brittleness which commonly attends the hardening of steel is obviated. This plate has been completed, and was the one tested.

The trial, which was conducted by Captain Hugo Pearson, of the *Excellent*, was witnessed by Mr. W. H. White, C.B., Director of Naval Construction, Admiral Colomb, General Geary, R.A., Captains Jenkins and McKechnie, of the Ordnance Committee, Colonel W. W. Barlow, late of Woolwich Arsenal, and other officials. The Harvey Steel Company, of New York, was represented by Mr. Edwin M. Fox and Mr. Joseph H. Dickinson, and the manufacturers by Messrs. Albert and Thomas Vickers.

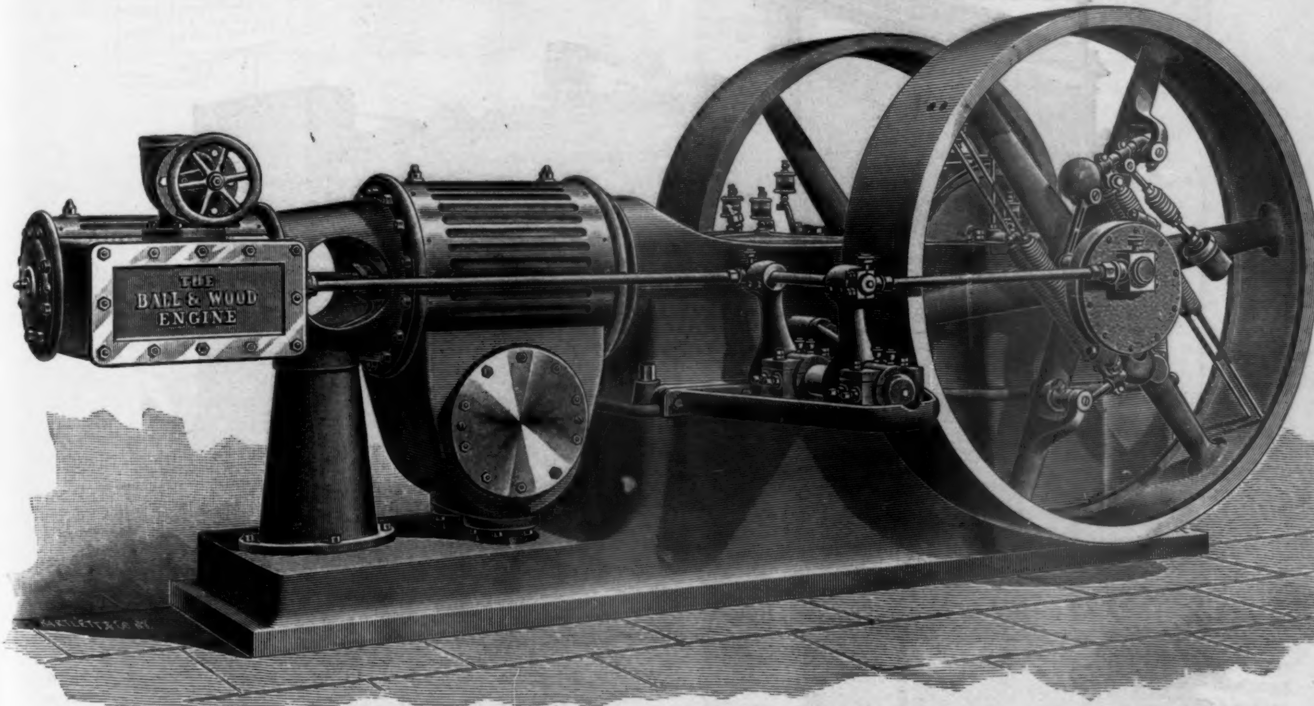
The plate measured 6 ft. × 8 ft., with a thickness of 10½ in. The test, for purposes of comparison, was of the ordinary character consistent with Admiralty conditions. This consisted of discharging five rounds at the target from the 6 in. breech-loader. The charge was 48 lbs. of E.X.E. powder, the weight of projectile 100 lbs., and the muzzle velocity 1,975 ft. per second. The rounds were fired in the following order: (1) Holtzer steel shell at bottom right-hand corner; (2) Holtzer at upper left-hand corner; (3) Palliser shell at upper right-hand corner; (4) Palliser at upper left-hand corner; (5) Holtzer in the center.

The results of the firing were most successful. The Palliser projectiles, although they splashed upon the plate on impact, made indents of about 1½ in. in depth. The Holtzers, on the other hand, appeared to weld their points into the target before bursting into a thousand highly heated fragments. The feature of the trial, however, was that the plate withstood its punishment so well that not a single crack was produced.

Further trials with thinner plates are to be carried out at Portsmouth, the results of which we look forward to with considerable interest.—*Industry, London.*

A New Tandem Compound Engine.

THE accompanying illustration, which by the courtesy of the builders we publish in advance of the appearance of their new catalogue, shows one type of an improved tandem compound engine built by the Ball & Wood Company. This engine has some novel and excellent features, a distinctive one being a new low-pressure valve recently invented by Mr. Ball. It has the advantage of quickly relieving the cylinder of water in case of flooding, and is, in its ease of action and small percentage of clearance, a decided advance on the valves heretofore used on this type of engine. Another good point is the manner in which the high-pressure cylinder is supported and allowance made for expansion and contraction.



NEW TANDEM COMPOUND ENGINE, BY THE BALL & WOOD COMPANY.

The governor used on this engine is of the well-known type made by this company and approved by continued use. To show the confidence placed in it we quote a clause of the guarantee under which every engine is sold: "That the engine shall not run one revolution slower when fully loaded than when running empty; and that no reduction of boiler pressure shall reduce the speed of the engine one revolution until the latest point of cut-off is reached, the same result being obtained when driving from either the governor wheel or balance wheel, or both."

The engraving shows very well the general design and arrangement of the engine. It is an exceedingly neat machine in its finish and general appointments. It is well known that our best types of engines will compare favorably with those of English or French manufacture, and that in this department, as with locomotives, our builders have no reason to fear comparison or competition from abroad.

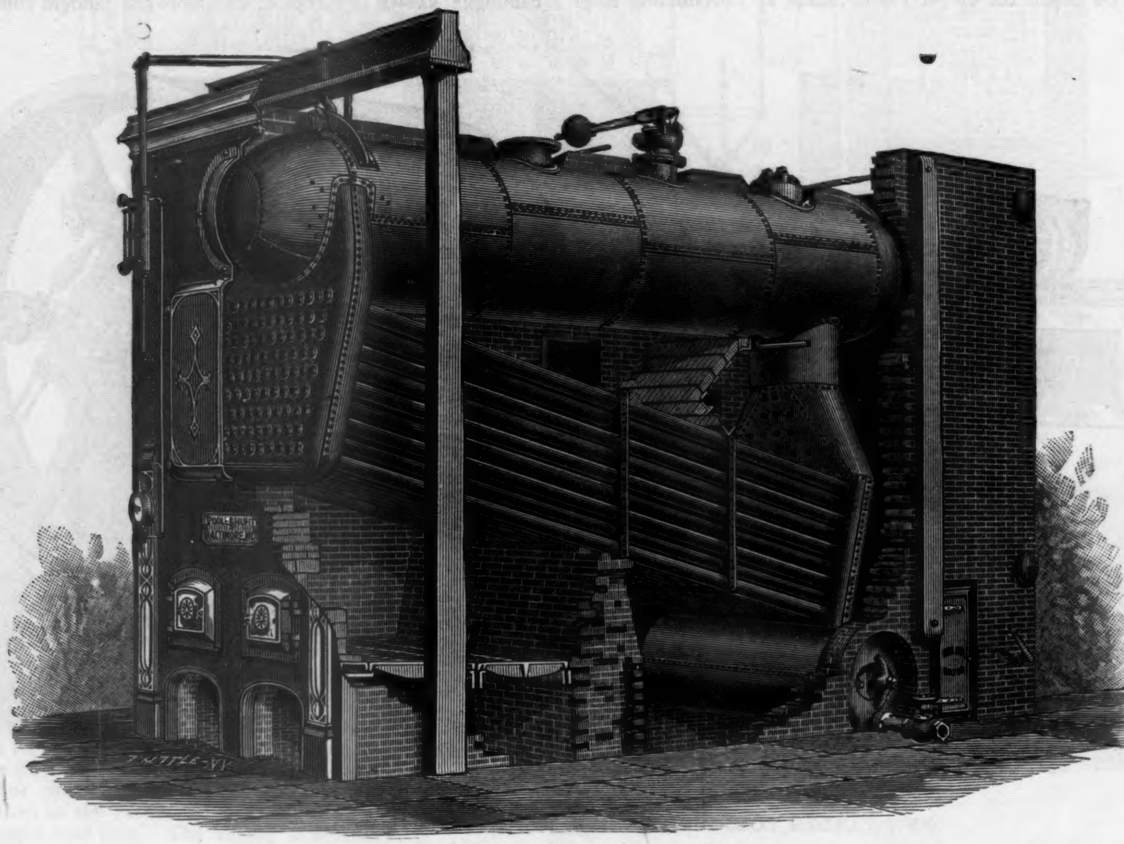
The Ball & Wood Company, whose office is at No. 15 Cortlandt Street, New York, have lately built new shops at Elizabethport, N. J., which are very fully supplied with tools of the most approved patterns, electric cranes and all the facilities for turning out a high class of work.

Manufactures.

The Poole Water-Tube Boiler.

THE illustration given herewith shows an excellent form of sectional or water-tube boiler made by the Robert Poole & Son Company, of Baltimore. The advantages claimed for this class of boilers are so well known that it is hardly necessary to restate them here.

The boiler shown is composed of lap-welded wrought-iron tubes, placed in an inclined position, and connected by vertical passages at each end, with a horizontal steam and water drum. The tubes are staggered, or so placed that one row comes over the spaces of the previous row. The vertical passages, or end connections, are made of two plates of the best flange iron, or steel, placed far enough apart to give full area for the circulation between the inclined tubes and horizontal drum. The plates are flanged at sides and bottom, and very strongly stay-bolted together. The tubes are expanded into the inner plate, and suitable hand holes in the outer plate admit the tubes and allow for cleaning. The connection to the drum is made in the strongest manner. The fire is made under the higher end of the tubes, and the products of combustion pass up between the tubes into a combustion chamber under the steam and water-drum; from thence they pass down across the tubes, then once more up through the spaces between the tubes, and off to the chimney.



THE POOLE WATER-TUBE BOILER.

The water, being inside the tubes, as it is heated tends to rise toward the higher end, and as it is converted into steam—the mingled column of steam and water being of less specific gravity than the solid water at the back end of the boiler—rises through the front end connection into the drum above the tubes, where the steam separates from the water, and the latter flows back to the rear and down again through the tubes in a continuous circulation. As the end connections are large (the full area of the tubes being maintained), this circulation is very rapid, and produces, the makers claim, three very important advantages:

"1. It sweeps away each particle of steam as fast as formed, and supplies its place with a particle of water, thereby absorbing the heat of the fire to the best advantage; and, thoroughly separating from the water in the large disengaging surface in the steam and water drum, prevents what is known as priming or foaming, the steam passing away from the boiler dry even when the boiler is forced to its utmost capacity.

"2. It causes a thorough commingling of the water throughout the boiler, and a consequent equable temperature, thus preventing those very serious strains from unequal expansion which occur in all boilers of ordinary construction, and which are a frequent cause of explosions.

"3. The rapid circulation prevents, to a great degree, the formation of deposits or incrustations upon the heating surfaces, sweeping them away and depositing them in the mud drum, at the rear and lowest point of the boiler, whence they are blown out."

A hand-hole at the end of each tube permits access thereto for cleaning should they become scaled by the use of very bad water, and man-holes in the steam and mud drums admit access to them for the same purpose. Should it be necessary, for any cause, a tube may be readily removed and another substituted. The front end of the boiler is suspended from a girder, supported by columns, entirely independent of the brickwork, and all the mountings, including gauges, safety valve, etc., are of the best and most approved patterns.

It will be seen that the boiler has all the advantages of its class. It is especially serviceable where high pressures have to be carried on account of its safety from explosion, ease of repairs and the quickness with which the pressure can be brought up.

A number of boilers of this type are in use, and they have given good results in all cases.

Subdivision of Power.

THE subdivision of power in large manufacturing establishments (by which is meant the substitution of several small engines in place of one large engine, and the distribution of power in the form of steam rather than by shafts and belts) has been a matter of active discussion of late. Originally looked upon as an experiment which might show against the fuel account, it was some time in gaining the confidence of manufacturers, as well as of engineers. The most persistent advocates of subdivided power, as engineers, have probably been Messrs. Westinghouse, Church, Kerr & Company, and many important plants have been designed by them on this basis. The results are beginning to speak for themselves, and are of interest.

When the great Spreckels sugar refinery was built some four years ago, and it was announced that Chief Engineer Watson and his associates had finally settled upon the radical departure of subdivided power throughout, many conservative engineers doubted the wisdom of an experiment upon so large a scale, and involving a position from which there was no line of retreat nearer than a complete reconstruction of the plant. It may be imagined that the decision was not arrived at except after the most deliberate investigation, but having been made, the problem was attacked boldly. Not only was the subdivision of power so completely carried out as to involve over 60 engines distributed on every floor of the enormous building, and practically doing away with shafting and belts altogether, but high-speed engines were selected, and most of them set without foundations. Non-compound engines were employed, from the fact that the various processes utilized all the exhaust steam which could be made.

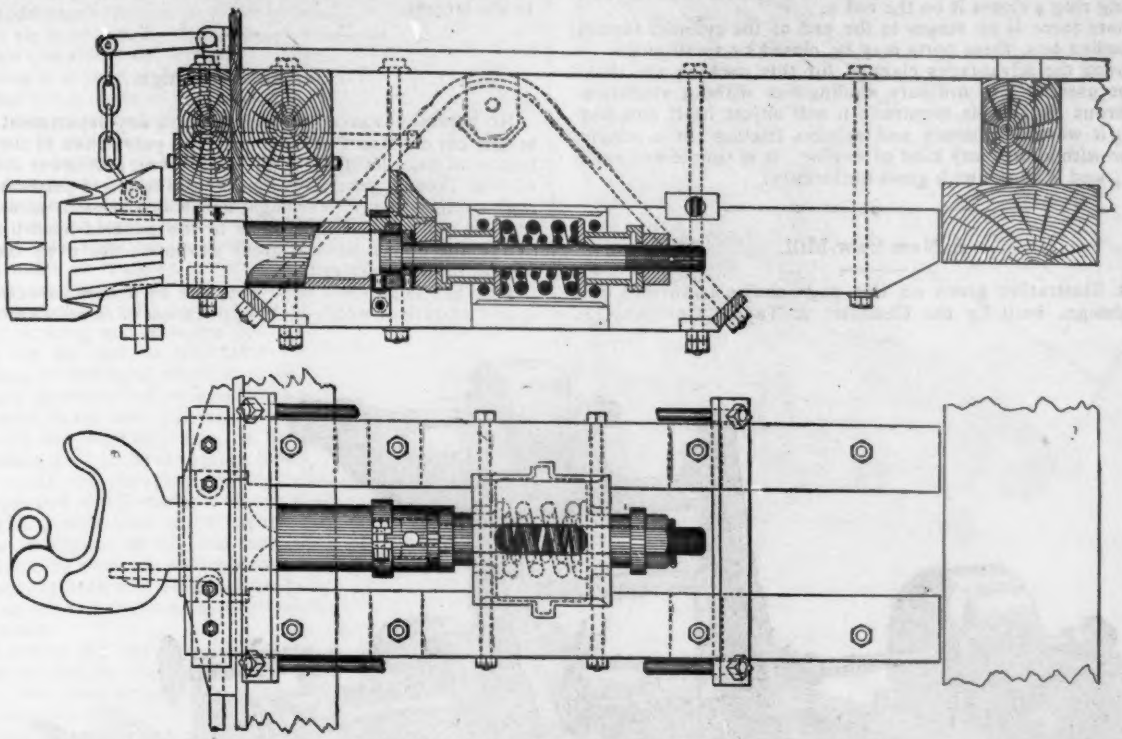
This refinery has since passed into the ownership of the American Sugar Refining Company, and further enlargements are now in progress. The experience of three years of operation, literally night and day, was brought to bear upon the question of future extension of power, and the decision may be taken as significant of the general result obtained. An order has just been placed for five more Westinghouse standard engines, four of 100 H.P. and one of 75 H.P., making 68 engines now operating in this refinery.

An interesting feature developed in this establishment has been in the matter of repairs and stoppages. The Master Mechanic keeps on hand a set of duplicate parts for each size of engine, and covering such parts of the engine as are most subjected to accident or wear. When a part is worn out, or an accident occurs, he gives the spare part to the engineer in charge of that particular department and it is at once put in place ; the old part being returned to the shop and overhauled at leisure. In this manner there is no measurable delay in the refining processes, which is the paramount consideration, and the maintenance account is reduced to practically nothing.

A similar subdivided plant, involving 42 engines, was installed at the print works of the Dunnell Manufacturing Company, Pawtucket, R. I., and its Chief Engineer reports that the total repair bill for the first year of continuous operation was less than $3.

The Butler Drawbar Attachment.

The drawings given herewith are from the catalogue of the Butler Drawbar Attachment Company, and show one form in which these attachments are used. The special feature of this construction is the truss-rods which are used for binding the draft timbers more rigidly to the center sills. Two flat bars extend across the two draft sills and beneath them, and passing through each end of each bar and over a cast-iron pocket provided in the center sills for their reception are the two truss-rods, one being on the outside of each draft sill. Directly underneath the draft sill and lying against the iron bars referred to are additional bars gained into and firmly bolted against the draft sills. The corners of the bars coming in contact prevent them from moving from their proper positions. A regular standard attachment of the Butler Drawbar Attachment Company is used. This attachment consists of the two castings which form the spring pocket and the springs and thimbles contained therein.



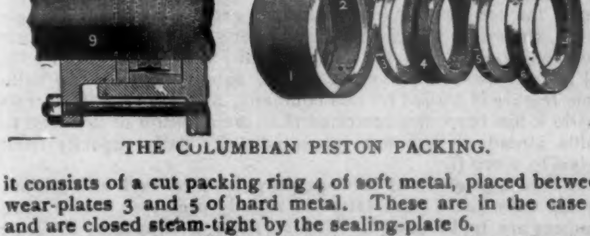
THE BUTLER DRAWBAR ATTACHMENT.

This drawing shows the ordinary draft-rod and nut on the drawbar. In another form a yoke extends around the attachment and spring and is riveted to the drawbar, making a very strong and simple connection.

These are only two of the ways in which the Butler attachments can be applied. They can be used to advantage with almost any of the ordinary forms of drawbar.

The Columbian Metallic Packing.

This packing, which is shown in the accompanying illustration, is self-adjusting, and has some features for which many advantages are claimed. A reference to the cuts will show that it consists of a cut packing ring 4 of soft metal, placed between wear-plates 3 and 5 of hard metal. These are in the case 1, and are closed steam-tight by the sealing-plate 6.



THE COLUMBIAN PISTON PACKING.

The case and sealing-plate fit loosely into the stuffing-box, and by screwing up the gland the case is forced against the bottom of the stuffing-box, forming a steam-tight joint to prevent escape of steam between stuffing-box and case.

If the bottom of the stuffing-box is too rough to form a per-

fect joint, a washer or ring of any kind of soft metal may be placed against it, and a tight joint can be made without difficulty.

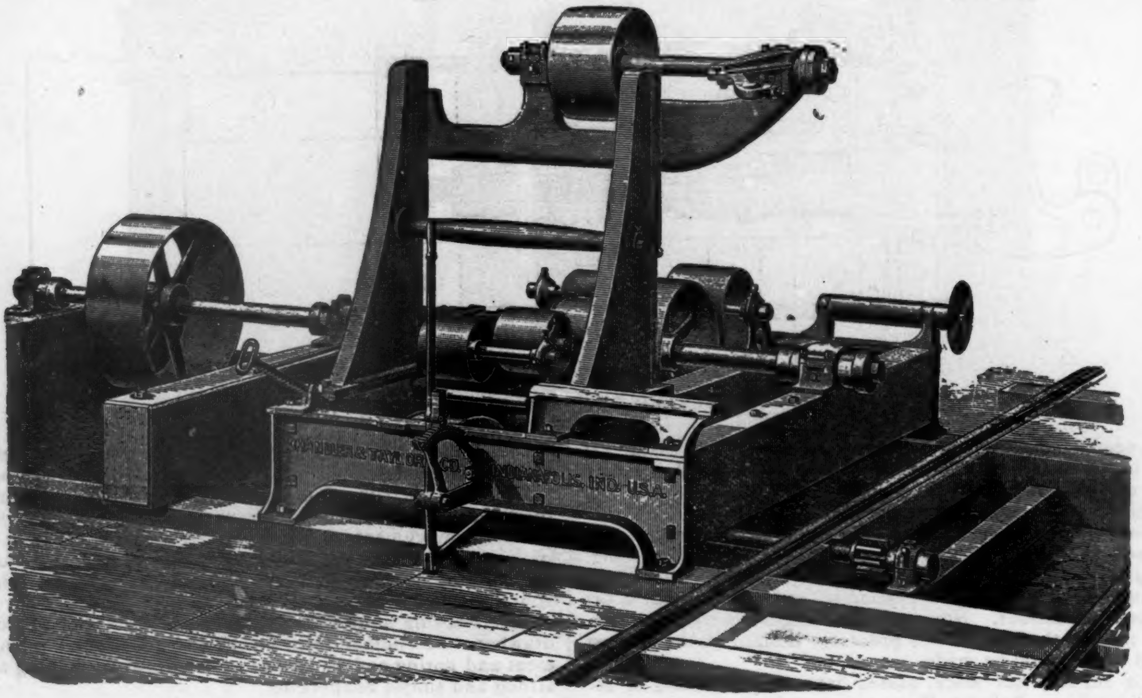
The bottom of the case is dished to form a steam chamber, and port-holes 2 leading from this chamber admit steam into the case; the steam pressure acting against the back of the cut packing ring 4 closes it on the rod 9.

Where there is no steam in the end of the cylinder forming the stuffing-box, these ports may be closed by small plugs.

Among the advantages claimed for this packing are that it can be used in any ordinary stuffing-box without alteration; no fibrous packing is required; it will adjust itself automatically; it works uniformly and reduces friction; it is adapted for use with almost any kind of engine; it is simple and easily fitted; and it works with great uniformity.

A New Saw-Mill.

THE illustration given on this page shows a saw-mill of a new design, built by the Chandler & Taylor Company, in Indianapolis, Ind., a concern which has had much experience with machinery of this kind, and has placed mills in many parts of the country.



NEW SAW-MILL BY THE CHANDLER & TAYLOR COMPANY.

The leading features given to this their latest design are a large mandrel with self-adjusting self-oiling boxes and an extension shaft with clutch coupling and lever and independent boxes which relieve the mandrel of the pull of the main belt, giving increased space for off-bearing and furnishing a means for driving edgers, cut-offs, log hauls, etc., without the intervention of a line shaft.

The Heacock patent belt-feed is provided with all mills of this design, which, aside from independent steam-feed, is the simplest and most powerful feed devised. With this arrangement the feed can instantly be changed by means of a single lever, shown in the cut at the sawyer's position, to give from no feed to 4½ ft. in the medium mill and from nothing to 7½ ft. feed on the heavy mill. The patent right for this valuable feature is owned by this company, and from practical tests made it has been demonstrated that the addition of this feed to mills already in use has increased their daily capacity from 1,000 to 2,000 ft.

A choice is given of carriage propulsion by rack and pinion, or by wire cable; the latter is usually preferred where long timbers are to be sawed. The carriage is supported by large track-wheels with axles extending from side to side of carriage, and these wheels in turn rest upon a track made of ordinary steel rails. The arrangement for sustaining the top saw mandrel is also to be noted. This mandrel is provided with an adjustable self-oiling device, and with devices whereby the teeth of the upper saws are made to cut out under the bark and carry the sawdust out of instead of into the kerf. These special devices, with the general details, arrangement and parts of the whole outfit, make a complete and substantial mill. Four sizes of these mills are built, all made after the general design shown in the cut and covering a range of capacity from the smallest to the largest.

Car Head-Linings.

NO greater advance has been made in any department of passenger car construction during recent years than in the manufacture of head-linings. Many readers can remember the painted head-linings, generally of gaudy and tasteless patterns, which were common a few years ago, and which are still occasionally seen in old cars. From these to the paneled head-linings of to-day there has been a great advance; but even these left something to be desired.

This has apparently been supplied by a new invention, the special feature of which is the application of raised or embossed decorations of tasteful pattern to the wood panels. While not intended as an imitation of wood-carving, these decorations present very much the same effect. The process is owned and controlled by the manufacturers, and the panels produced are not only handsome but strong and apparently very durable, the decorations or embossing put on by the company's process becoming attached to—or, it might be said, incorporated with—the panel in such a way that when cut or sawed through they seem to be part of the wood itself.

In this way very handsome panels for head-linings are produced at a cost not exceeding that of the linings now in use. Of course the effects can be varied according to taste by the use of panels of various kinds of wood in combination with different decorations.

These head-linings are manufactured by the Bowers Manufacturing Company, of Newark, N. J. On a recent visit to the company's shops, in Harrison, a number of panels were seen in process of manufacture, including panels of quartered oak, maple and other woods, and some very beautiful work in white and gold, the latter being intended for some cars under construction for a new electric line. Car-builders who want to turn out handsome cars will find these new decorations well worth inspection.

The Thacher Pneumatic Dump Car.

AN interesting exhibition of the capacity of this car for quick work was given recently on the Erie road at Garfield, N. J.

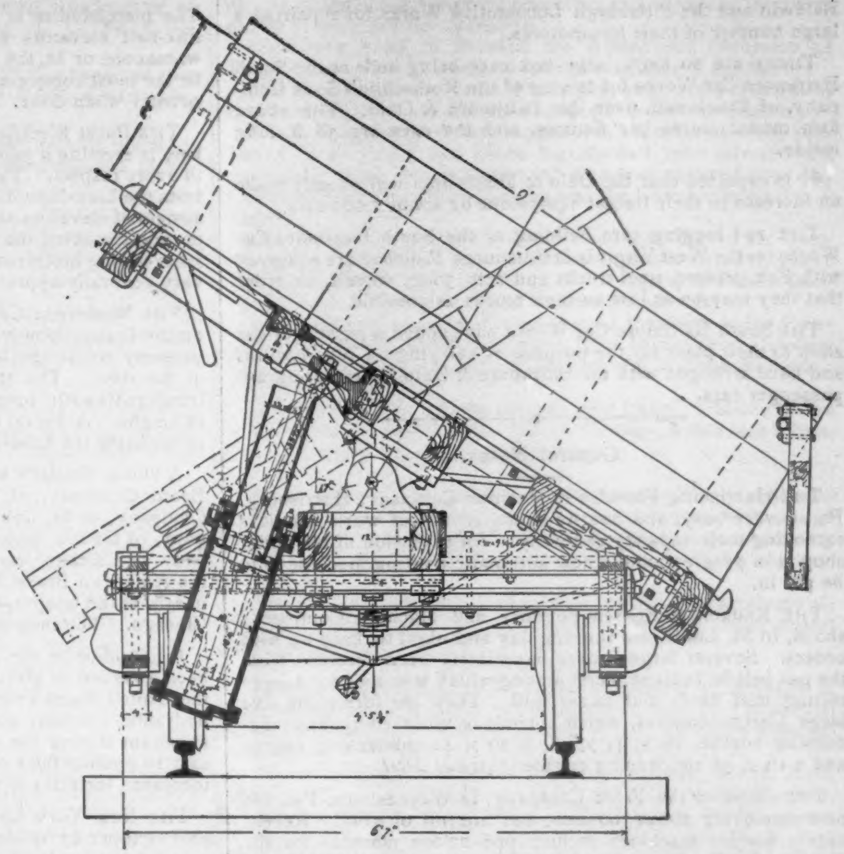
The cars used had been in active service, and their operation was so quick that it was hardly possible to time it.

The machinery of the car is simple, the operation of dumping being performed by a piston working in a cylinder underneath the car, to which compressed air is admitted. If the car is to dump on one side only, it is level when the piston is at the bottom of the cylinder; but if it is made to dump on either side, it is level when the piston is at the center of the cylinder. The air is taken from the reservoir on the locomotive; or an additional reservoir can be carried if it is considered necessary. Two train-pipes lead from the reservoir, and the air can be admitted to either end of the cylinder as required. The accompanying drawing shows a section of the car with the body raised to dump.

The latching and releasing device by which the car body is held level while running, or released when it is to be dumped, is controlled by a small cylinder which in the later patterns is cast in one with the large cylinder. It has no separate pipe, but the air passes through it to reach the dumping cylinder; an arrangement which makes it certain that unlatching will take place before the power is applied to lift the car body. The latching device is a simple one, and will spring back and hold the car body level as soon as the latter is thrown back into place.

Of course the simplest form is that in which the car dumps on one side only; but there is very little additional complication where it is made to dump on both sides. It can also be readily applied to coal cars dumping in the center. There is no doubt that it saves time and labor, and some experiences already had seem to show that it will stand the rough usage to which dump cars are often exposed.

These cars are made by the Thacher Car & Construction Company, of New York. A number have been in use on a narrow-gauge line in Colorado for some time; and the Canadian Pacific Company has 50 of large size in use, and at present employed in filling a high trestle near Vancouver, where they are said to work very much to the satisfaction of those in charge.



THE THACHER PNEUMATIC DUMPING-CAR.

Lake Ship-building.

THE Detroit Dry Dock Company has just closed a contract with Detroit parties for a "straightback" steel steamer 362 ft. long, 42 ft. beam and 24 ft. deep, to be an almost exact duplicate or sister ship to the steamer *Selwyn Eddy*, now nearing completion at Wyandotte. The only difference between the *Eddy* and the new contract is that there will be no gangways. The boilers will be on the main deck instead of in the hold and sheer to bulwarks on the side.

LAKE ship-builders now have contracts to build during the coming winter, for delivery at about the opening of navigation, 49 vessels, valued at $6,909,500. These totals, together with the valuable detail regarding the new tonnage which is contained in the accompanying table, were secured through correspondence with every ship-builder on the chain of lakes, and the comparison with fall contracts in previous years is made in accordance with a similar inquiry in the past. The record in both the number of vessels and aggregate value for this year is very much ahead of the two previous years, but it will be found by a glance at the comparative table that in both number and carrying capacity the showing in large freight-carrying steamers is somewhat smaller than in any year for six years past. This is due largely to the fact that three of the most important steel yards are crowded with work on the large passenger vessels. Twenty-eight freight steamers and consorts, of 68,470 gross tons capacity, will, however, be added to the fleet of this class of vessels in the spring.

The following table shows the number and value of contracts on November 1 of this year as compared with contracts on the same date in previous years:

WINTER OF.	Number of Boats.	Capacity gross tons.	Valuation.
1886–87	31	65,750	$4,074,000
1887–88	60	108,525	8,325,000
1888–89	59	100,950	7,124,000
1889–90	56	124,750	7,866,000
1890–91	38	77,950	5,337,000
1891–92	45	76,000	4,896,000
1892–93	49	68,470	6,909,500
Total	338	632,395	$44,531,500

The totals represent simply the winter work of the ship-yards and not their entire work for the several years.—*Cleveland Marine Review.*

Baltimore Notes.

THE Baltimore & Ohio Railroad Company has just finished at Benwood, W. Va., one of the most complete round houses in the country. It is about 300 ft. in diameter, and has stalls for 24 engines. The ash-pit is 200 ft. long, which is three times the usual length, and will admit of the cleaning of three engines at a time. An immense coal dump for furnishing the engines with coal has also been built, and several large water tanks have been constructed. The bridge which connects Bellaire, O., and Benwood is being strengthened on the west side, so as to admit of the crossing of the heaviest engines in the service. It is also intended to lay 11 miles of tracks and to build new repair shops in the yard at Benwood.

THE laying of track for the new alignment of the Baltimore & Ohio near Cumberland has been begun, and it is expected that the new short line will be ready for service in about a month. As soon as this is completed, the work of grading for the new yard will be begun.

IN addition to placing orders for a number of new engines, the Baltimore & Ohio Railroad Company has arranged with the

Baldwin and the Pittsburgh Locomotive Works for repairing a large number of their locomotives.

THERE are 20 extra large box cars being built at the South Baltimore Car Works for the use of the Rothschild's Sons Company, of Cincinnati, over the Baltimore & Ohio. The above firm manufactures bar fixtures, and the cars are 38 ft. long inside.

IT is expected that the Ohio & Mississippi will shortly make an increase in their freight equipment by about 1,000 cars.

THE 100 logging cars building at the South Baltimore Car Works for the West Virginia & Pittsburgh Railroad are equipped with Fox pressed steel trucks and with 30-in. wheels, in order that they may be as low on their trucks as possible.

THE South Baltimore Car Works have added a passenger car shop to their plant for the purpose of carrying on repair work, and have arranged with the Baltimore & Ohio for repairing 200 passenger cars.

General Notes.

THE Harrisburg Foundry & Machine Company, Harrisburg, Pa., is very busy, and has its shops so full of work that it is extending their capacity generally. An extension of the boiler shop is in progress, and a new automatic riveting machine is to be put in.

THE Ranken & Fritsch Foundry and Machine Company's shops, in St. Louis, are running day and night to keep up with orders. Several large orders have lately been received from the gas belt in Indiana, chief among which was that for a large rolling mill outfit and paper mill. They are furnishing five large Corliss engines, which include a cross compound condensing engine, 26 × 44 × 48, a 20 × 42 condensing engine and a 16 × 36 condensing engine.—*Age of Steel.*

THE shops of the Frick Company, in Waynesboro, Pa., are now employing about 700 men, and are full of work. Recent orders for ice machines include one 20-ton machine for the Crisfield Ice Company, Crisfield, Md.; 50-ton machines for the Springfield Ice Company, Springfield, O., the Pottstown Ice & Cold Storage Company, Pottstown, Pa., and the Thomas Conville Brewing Company, New York; one 150-ton plant for the Hauck Brewing Company, Cincinnati; one 300-ton plant for the United Beef Company, New York. In the engine department orders include one 150-H.P. Eclipse Corliss engine for the Eastman Kodak Company, Rochester, N. Y., and one 200-H.P. engine for the United Beef Company, New York.

THE Dickson Manufacturing Company, in Scranton, Pa., is building a large quadruple-expansion engine for the Edison Illuminating Company of New York. The engine is of the vertical inverted type, with the cylinders arranged in pairs tandem, and acting on two cranks placed at an angle of 90°. The dynamo will be built up around the main shaft, taking the place of a fly-wheel. The cylinders are 26 in., 37 in., 52 in. and 72 in. in diameter and 36 in. stroke. With a boiler pressure of 210 lbs. and at 100 revolutions per minute the engine is rated at 2,500 H.P. This is the first large engine of this type built in this country.

THE Cooke Locomotive Works, Paterson, N. J., recently delivered to the Newport News & Mississippi Valley Company eight passenger engines with 18 × 24-in cylinders and 63-in. drivers. They are to run the through trains between Louisville and Memphis.

THE Safety Car Heating and Lighting Company is making preparations for an extensive exhibit at the World's Columbian Exposition to be held in Chicago next year. This will not only show their system of lighting as applied to ordinary coaches, but also to sleeping and drawing-room cars, as well as the gas-lighted buoys, which have been generally adopted by this Government as the means of lighting the various channels and harbors along our coast.

THE firm of Shailer & Schniglau, of Chicago, has secured the contract for building the Canal Street lifting bridge, which will be operated by four powerful chain belts.

THE Pittsburgh Bridge Company, Pittsburgh, Pa., has secured the contract for erecting the Halsted Street lifting bridge in Chicago, which will be operated the same as the Canal Street bridge.

THE Link-Belt Machinery Company, Chicago, is putting in a complete system of rapid freight-handling machinery in the new warehouses of the Flint & Père Marquette Railroad, at Milwaukee. The plant comprises three elevators and six conveyers. The merchandise is delivered directly from the wagons to the link-belt elevators and automatically deposited either in the warehouse or in the hold of vessels. It is believed this will be the most completely equipped warehouse of the kind in the country when done.

THE Pabst Electric Light, Heat & Power Company, Milwaukee, is erecting a power house and will make it a model plant in every respect. The company has just accepted a proposition from the Link-Belt Machinery Company, Chicago, for a complete system of elevators and conveyers for supplying coal to the boilers and removing the ashes. The economy and convenience of labor-saving machinery of this character in boiler houses is being very generally appreciated.

THE Wisconsin Central Railroad has just commenced work on the foundations for a freight house, to be located on their property in Chicago, below Harrison Street, and on the east side of the river. The structure will be 500 ft. long, have a water frontage its entire length, and will be 95 ft. wide and three stories in height. A liberal use of labor-saving machinery is intended to facilitate the handling of all kinds of freight.

A PRESS dispatch says that the Schoen Pressed Steel Brake Beam Company, of Pittsburgh; the Universal Brake Beam Company, of St. Louis; the Michigan Railway Supply Company, of Detroit, and the Northwestern Railway Supply Company, of Chicago, have formed a combination to be known as the American Brake Beam Company. H. W. Oliver, of Pittsburgh, is the temporary President. The main office will be in Chicago. The incorporated capital is $2,500,000.

A LARGE order for hydraulic projectile drawing presses has been awarded to Messrs. Watson & Stillman, of New York, by the United States Projectile Company of Brooklyn. Orders for hydraulic presses, pumps and accumulators have been so abundant during the past year that it has been found necessary to operate their plant both day and night, notwithstanding increased facilities in the several departments.

THE New York Locomotive Works, in Rome, N. Y., were sold October 27 by the Referee, and were bought by a committee representing the holders of first-mortgage bonds for $197,074, subject to the mortgage of $150,000. The purchasers will organize a new company and will put the works in operation again; but it is said that they will not continue the construction of locomotives.

RECENT orders at the Baldwin Locomotive Works, Philadelphia, include 45 consolidation freight engines for the Pennsylvania Railroad, and 50 locomotives for the Philadelphia & Reading.

THE Chester Steel Casting Company is about to erect an enlargement to its foundry 50 × 50 ft., a furnace house 40 × 40 ft. and a gas house 50 × 80 ft.

THE Corliss Steam-Engine Company, Providence, R. I., is building a 500-H.P., cross-compound condensing engine for the American Screw Company. The engine has a stroke of 4 ft., and its cylinders are 20 and 36 in. in diameter.

THE Buffalo Car Wheel Foundry Company has been organized and will build works in Buffalo, N. Y., with a capacity of 500 car wheels a day.

THE Thurmond Car Coupling Company has leased all its appliances, including the coupler and McKeen tender hook and carry iron, to Isaac G. Johnson & Company, of Spuyten Duyvil, N. Y., manufacturers of steel and malleable iron. T. L. McKeen has leased his continuous platform and buffer to the same firm, and will have charge of the manufacture of the appliances. The office at 80 Broadway, New York, will be continued, with Mr. Hascall in charge, representing Johnson & Company.

PERSONALS.

WILLIAM KENT has removed his office as Consulting Engineer and Metallurgist to No. 35 Warren Street, New York City.

G. BACON PRICE has opened an office as Mechanical Engineer at No. 308 Walnut Street, Philadelphia. Mr. Price was for a number of years Chief Examiner at the Baldwin Locomotive Works.

A. FTELEY, Chief Engineer of the New York Aqueduct Commission, recently delivered an interesting and valuable lecture on the Construction of Dams before the students of the Rensselaer Polytechnic Institute in Troy.

J. W. SHANKS has been appointed General Roadmaster of the Central Vermont Railroad, succeeding A. C. BEAN, deceased.

L. C. FRITCH has been appointed Chief Engineer of the Ohio & Mississippi Railroad, succeeding C. C. CHANDLER, who has resigned.

A. LEOFRED, Mining Engineer, of Quebec, reports much interest in mining matters. He is constantly employed in examining and reporting on mining properties.

COLLINGWOOD SCHREIBER, for some years past Chief Engineer of the Canadian Department of Railways and Canals, has been appointed Deputy Minister of the Department. He will still remain Chief Engineer.

H. B. HODGES has been appointed Engineer of Tests of the Baltimore & Ohio Railroad, to succeed L. S. RANDOLPH, resigned. Mr. Hodges was formerly Superintendent of Tests of the Union Pacific Railway.

C. E. FULLER, JR., has been appointed Superintendent of Motive Power of the Central Vermont Railroad, with office at St. Albans, Vt. He has been for some time on the New York, Lake Erie & Western road.

F. R. F. BROWN has been appointed Mechanical Superintendent of the Intercolonial Railway. He has served on the Grand Trunk and the Canadian Pacific, and has recently been Superintendent of the Dominion Bridge Company.

W. J. ROBERTSON, for some time past Superintendent of Motive Power of the Central Vermont, has been appointed Master Car-Builder, and will have entire charge of the Car Department, which has been separated from that of Motive Power.

OBITUARIES.

COLONEL ROBERT C. MORRIS, who died in Nashville, Tenn., November 8, was born in Tennessee in 1817. He served as Assistant and Resident Engineer on the East Tennessee, Virginia & Georgia for some time, and since 1869 had been Chief Engineer of the Nashville, Chattanooga & St. Louis Railroad. Nearly all the branches and extensions of that road were located and built under his direction.

ZENAS KING, the well-known bridge-builder, died in Cleveland, O., October 25, aged 74 years. Born in Kingston, Vt., and engaged on the farm until he reached man's estate, his start in business was as a contractor for the erection of buildings. His mechanical skill, developed in this work, came to his help later, when as a traveler for the Mosley Bridge Company he began studying to improve upon wooden bridges. In 1861 he obtained a patent for the King iron bridge, and erected works in Cleveland to manufacture bridges and boilers. His partner, Mr. Freese, took the boiler department on the dissolution of the firm some time later. Mr. King resolutely pushed his business, and succeeded by hard work in introducing them on highways all over the country. In 1871 he organized the King Bridge Company, of which he was, at the time of his death, the President and Manager. In recent years Mr. King was very largely interested in the building of long bridges. The finest of that character is the one between Covington, Ky., and Cincinnati. Last winter he engaged in an enterprise to build another bridge between Cincinnati and Newport. About a year ago a company, in which he was largely interested, was chartered in New York State for the purpose of building another bridge from New York City across the East River.

PROCEEDINGS OF SOCIETIES.

American Railway Association.—The semi-annual meeting of the American Railway Association was held at No. 24 Park Place, New York City, on Wednesday, October 12, 1892; the President, Mr. H. S. Haines, in the chair.

Fifty-eight representatives, representing 42 roads, were present.

The date selected for the general fall change of time-tables was November 13.

The Executive Committee reported having received applications for membership from the Boston & Maine, Chattanooga Southern and the Concord & Montreal Railroad companies, which have been duly approved; making the total membership 180 companies, operating 128,062 miles of road.

The following-named gentlemen were appointed on the Nominating Committee: C. H. Platt, F. S. Gannon, C. Neilson.

The President's address was then delivered. It treated chiefly of the block system of operating and of needed improvements in the rules for operating.

Some new Rules, to Prevent the Misuse and Diversion of Freight Cars were adopted, to take effect January 1, 1892:

The Committee on Train Rules proposed some changes in the Standard Code, which were adopted by the Association.

The Committee on Safety Appliances reported that the subject of Interlocking and Block Signals had been referred to a joint sub-committee, consisting of members selected from the Committee on Safety Appliances and the Committee on Train Rules.

The following companies were elected members of the Committee on Car Service, their terms to expire in October, 1895: Pennsylvania Railroad; Chicago, Rock Island & Pacific Railroad; Lake Shore & Michigan Southern Railroad.

The following companies were elected members of the Committee on Safety Appliances, their term to expire in October, 1895: Pennsylvania Railroad; Delaware & Hudson Railroad; Old Colony Railroad.

A resolution was offered that the next (April) meeting of the Association be held in the city of Chicago, which was adopted, after which the meeting adjourned.

Roadmasters' Association of America.—The annual convention met in Chattanooga, Tenn., November 15, with a large attendance. On the following day the members proceeded by special train to Atlanta, Ga., where the rest of the sessions were held.

The meeting was carried out according to the programme already published, and was a successful one. A fuller report will be given later.

American Association of Superintendents of Bridges & Buildings.—The annual convention was held in Cincinnati, October 18 and 19. A large number of new members were admitted.

The following officers were elected: President, H. M. Hall, Olney, Ill.; Vice-Presidents, J. E. Wallace, G. W. Hinman, N. W. Thompson, C. E. Fuller; Secretary, S. T. Patterson, Concord, N. H.; Treasurer, G. M. Reed, Cleveland, O.; Executive Committee, G. W. Andrews, J. Staten, J. M. Caldwell.

Reports were presented by committees on Paints for Iron Structures; Surface Cattle Guards; Frame and Pile Trestles and Rerailing Frogs; Interlocking Signals; Iron and Vitrified Pipe Culverts; Water Tanks; Framing Wooden Trusses and Protecting them from Fire and Decay, and Depot Platforms.

The Report on Painting recommended pure linseed-oil and lead as the best paint for iron exposed to the weather. The Cattle Guard Committee presented two reports, one favoring the pit guard, the other the surface guard. The report on Pipe Culverts favored iron pipe, and claimed that vitrified pipe gave trouble by breaking at the ends from the action of frost. Vitrified pipe was recommended for use on sidings and in place of wooden sluice boxes at road crossings. The report on Wooden Bridges gave the average life of unprotected wood trusses at 7½ years, the parts which fail first being the lower chord, clamps and packers. Roofing wooden bridges was not favored, on account of danger from fire; but it was recommended that the lower chords be covered with galvanized iron run under the angle-blocks and gib plates.

The next meeting will be held in Philadelphia in October, 1893. Among the subjects on which committees will report are the following: Discipline, Turn-tables, Water Columns, Coaling Stations, Creeping of Rails, Bridge Guard Rails, Platforms, Bridges for Spans above 130 ft.

American Society of Mechanical Engineers.—The winter meeting was to be held in New York, beginning November 29. The programme arranged is as follows:

Tuesday, November 29.—Evening, opening meeting and delivery of the President's address.

Wednesday, November 30.—Morning, meeting for business, reading of papers and topical discussions. Afternoon, visits to points of interest about the city. Evening, reception and conversazione.

Thursday, December 1.—Morning, session for reading of papers and discussion. Afternoon, visits to points of interest. Evening, session for reading of papers.

Friday, December 2.—Morning, session for reading of papers and for concluding business.

American Society of Civil Engineers.—At the regular meeting, November 2, the committee appointed to prepare a memoir of James B. Francis, resigned, and at its own request was succeeded by his intimate friends, the Past Presidents George S. Greene, William E. Worthen and Julius W. Adams.

The Secretary read a paper on Electric Rock Blasting—the American Method, by W. L. Saunders. This was followed by an interesting discussion.

The tellers announced the following elections:

Members: Professor William W. Carson, Knoxville, Tenn.; Horace Harding, Tuscaloosa, Ala.; Benjamin S. Wathen, Dallas, Tex.; Professor J. H. Kinealy, St. Louis.

AT the regular meeting, November 16, a paper on Repairs and Maintenance of Roads was read by James Owen, and was discussed at some length by members present. The Secretary urged all to use every opportunity to help in securing better road laws.

Canadian Society of Civil Engineers.—At the regular meeting in Montreal, October 28, the first order was the discussion of Mr. Gilpin's paper on the Use of Safe Explosives in Coal Mines.

The discussion was followed by the reading of a paper by Mr. H. R. Lorde on Transition Curves. This was followed by a brief discussion.

AT the regular meeting in Montreal, November 11, the first order was the discussion of Mr. H. R. Lordly's paper on Transition Curves, read at the preceding meeting.

Mr. D. H. Keeley then read a paper on the Simplification of the Quadruplex. Discussion was postponed to the next meeting.

American Society of Irrigation Engineers.—This society, organized some time ago at Salt Lake City, has elected the following-named officers: President, Arthur D. Foote, Boise, Idaho; Vice-President, G. G. Anderson, Denver, Col.; Secretary and Treasurer, C. L. Stevenson, Salt Lake City, Utah. The Board of Directors is Professor L. G. Carpenter, Fort Collins, Col.; Harry I. Willey, San Francisco; J. S. Greene, Denver. The headquarters remain at Salt Lake City.

Franklin Institute.—At the regular meeting, in Philadelphia, October 19, Mr. F. Lynwood Garrison was elected a member of the Committee on Science and the Arts in place of Dr. George A. Koenig, resigned.

Mr. F. E. Ives read a paper descriptive of the principles of construction and operation of the Heliochromoscope, a new optical instrument of his invention for the reproduction of natural colors in photography.

Mr. S. Y. Buckman described an automatic Tin-plate Machine of his invention, and in connection therewith gave a sketch of the present state of the art of making tin plates.

Mr. W. E. Lockwood described the Boyer Railroad Speed Recorder and an Improved Smoke and Spark-consuming Device in Locomotive Practice.

New York Railroad Club.—At the regular meeting, October 20, there were no papers announced, but several topics had been selected by the Executive Committee for discussion. The talk of the evening was opened by Mr. W. G. Berg, Engineer Lehigh Valley Railroad, on the subject of the Best Plan for Railroad Shops, Rectangular or Radial. Mr. Berg spoke at considerable length, and was followed by Mr. Forney, who described in some detail with blackboard sketches a plan of shops that he had recently recommended, in which the several buildings were grouped around and commanded by a central turntable.

Another topic discussed was Locomotive Driving-Wheel Boxes, with special reference to the best way of lining them up to reduce lateral play.

AT the annual meeting, November 17, the following officers were elected: President, R. C. Blackall; First Vice-President, George W. West; Second Vice-President, A. E. Mitchell; Third Vice-President, W. H. Lewis; Secretary, J. A. Hill; Treasurer, C. A. Smith; Executive Committee, Thomas Millen, W. C. Ennis, H. H. Vreeland, W. W. Snow and W. G. Wattson; Finance Committee, Thomas Prosser, E. H. Andress and F. M. Patrick.

Boston Society of Civil Engineers.—At the regular meeting in Boston, November 16, Mr. E. K. Turner read a paper on English Railroads, and a general discussion followed.

New England Railroad Club.—At the regular meeting in Boston, November 9, the subject of the System and Appliances Necessary for Higher Speed of Trains was opened by Mr. C. A. McAlpine, who spoke at considerable length. An interesting discussion followed, in which Messrs. Chamberlain, Marden, Coughlin, Lauder and others took part.

Engineers' Club of Philadelphia.—At the regular meeting, October 15, Mr. John C. Trautwine, Jr., presented notes on the Distribution of Pressure in Masonry Joints, illustrated with sketches on the blackboard.

Mr. Wilfred Lewis gave an account of his Investigation of the Strength of Gear Teeth, beginning with a reference to the elementary character of the problem and the great diversity of rules adopted by many recognized authorities, and showing that although the form of a tooth had long been known to be an important factor in the determination of its strength, none of the rules in common use took account of the strength as affected by the number of teeth in the wheel or pinion.

Virginia Association of Engineers.—At the fall meeting, held at Roanoke, Va., October 22, a report on country roads was made by Oscar Saabye and Clarence Coleman. The report cited the difficulties in the way of building good roads in Virginia, and submitted plans of cross sections for earth, gravel and macadam roads.

The report advocated the repeal of the personal labor law and the enacting of a wide-tire law with a refunding provision.

The Association will meet monthly hereafter.

Engineering Association of the South.—The regular October meeting of this Association was held in Nashville, Tenn., October 13.

Mr. Ernest William Walpole, City Engineer of Talladega, Ala., was elected a member.

The programme of the evening included two papers; the first on the Mining Interests of Nova Scotia, by Mr. Frank Cawley, of Montreal, Canada.

Mr. Thomas Sharp, of Nashville, then presented a paper on the Spathic Ores and Iron of Lawrence County, Tennessee.

Engineers' Society of Western Pennsylvania.—At the regular monthly meeting, October 18, Mr. W. G. Wilkins was appointed to obtain papers from the members to be read at the Congress of Engineers, Columbian Exposition, on the list furnished by the American Institute of Civil Engineers.

The following applicants were elected to membership: Maurice Coster, W. A. Corcoran, George F. Greenwood, W. A. Herron, W. H. Hays, Walter H. Jackson, Horace W. Lash, William G. Musse, Reuben Miller, Jr., H. H. McClintic, Charles H. Snyder.

Mr. George H. Hutchinson then read a paper on Mill Building Construction, presenting a brief statement of the more important conditions which should govern the design and construction of modern mill buildings.

Civil Engineers' Club of Cleveland.—The regular meeting of the Club was held November 8. John G. Oliver and George C. Bardons were elected active members, and Charles Orr an associate member. The paper of the evening was read by Dr. E. W. Marley, Professor of Chemistry of Adelbert College, on the subject of Weighing Gases, in which some important and interesting experiments for the determination of atomic weights were described.

Michigan Engineering Society.—The Board of Directors met in annual session at Grand Rapids, Mich., October 12, and after canvassing the letter ballots for the election of officers, announced the election of the following-named persons: President, E. W. Muenscher, Manistee; Vice-President, George Pierson, Kalamazoo; Secretary and Treasurer, Frank Hodgman, Climax; Directors, Dorr Skeels, Grand Rapids; William Appleton, Lansing; Professor E. A. Davis, Ann Arbor. The annual meeting of the Society will be held in Lansing the third week in January, and one session will be devoted to the consideration of the road improvement problem. The Society has 150 active members.

Engineers' Club of St. Louis.—At the regular meeting of October 19, the by-laws were amended.

Mr. W. H. Bryan then read the paper of the evening on Steam Engine Efficiency: Its Possibilities and Limitations. Mr. Bryan called attention to the popular idea of steam-engine efficiency, alluding briefly to failures which had occurred in attempting to secure expected results from high efficiency machinery. He dwelt upon the ideal engine as distinguished from the real engine met with in every-day service, and showed that the perfect engine itself is of low efficiency on account of the narrow limits of temperature within which it is possible to work.

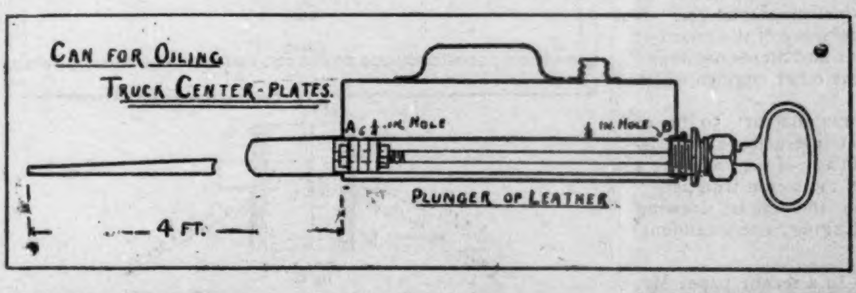
Discussion followed by Messrs. Olshausen, Seddon, Laird, Johnson, Perkins and Schlosser.

NOTES AND NEWS.

A New Steamer for Long Island Sound.—Work has been begun at the Delaware River Iron Ship-building & Engine Works, Chester, Pa., on a new boat for the Old Colony Steamboat Company, which is to exceed the well-known *Puritan*, *Pilgrim* and *Plymouth* of the company's Fall River line, in size and general excellence of her appointments. The new boat will be 440 ft. long over all; 424 ft. on water-line; 20 ft. 6 in. depth of hull; beam over hull, 52 ft.; beam over guards, 92 ft. She will be constructed entirely of steel, and will be absolutely fire-proof. She will have a double hull on the bracket system, divided into 58 water-tight compartments. The motive power will be supplied by double inclined compound engines of 8,000 H.P., working side-wheels with feathering buckets, and the boat will be fitted with 10 Scotch boilers and two smoke-stacks. The speed expected to be obtained is 22 knots per hour. Accommodation is planned for about 1,500 passengers in between 400 and 500 state-rooms; while the freight-carrying capacity will be 1,000 tons or more. The general design and arrangements are almost similar to those of the *Puritan*, with the exception of the saloon, which will be placed on the main deck aft, instead of below. The cost is calculated to reach the neighborhood of $1,250,000.

A Remarkable Gun.—A cannon which is preserved in the War Museum in Vienna can boast of an adventurous career. It was cast in the year 1568 by the then renowned gunmaker, Herr Hans Christoph Löffler, whose foundries were situated a Hütting, near Innsbruck, and it is of the class of ordnance known as the three-quarter carronade. In addition to the name of the Emperor Maximilian II., it bore, and still bears, the following inscription: "Ich bin ein Hahn—ein redlich Mann—der krähen kann—dass Thurm und Maver—zu Boden gan," a specimen of mediæval German doggerel which is intended to signify that the weapon is a cock which, by its crowing, can cause towers and walls to fall. At Raab this bronze chanticleer, as Arabic engraving clearly indicates, came into possession of the Turks, and it was conveyed to Serajewo, whence it was dispatched to the border fortifications at Kanisa. On April 1, 1692, it was recaptured by the Austrians when General Batthyanyi stormed the Hungarian fortress. In the year 1738, at Belgrade, the gun found itself once more in the hands of the Moslems. Then all trace of it was lost until in 1878 the Hapsburg troops discovered the old and now much battered cannon among the artillery of the Herzegovinians at Mostar.

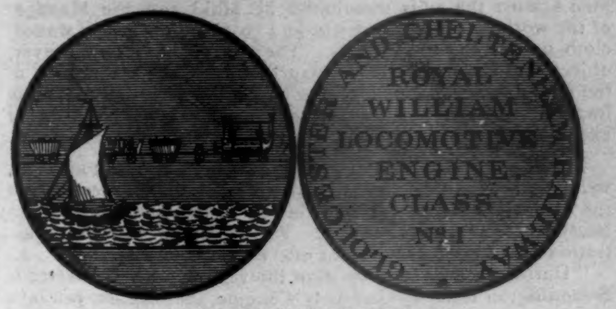
A Handy Center-plate Oiler.—The sketch given herewith shows an oil can used on one of our leading railroad lines for oiling the truck center-plates of freight cars. The can is made of galvanized iron and is 3 in. in diameter and 10 in. long; the spout is 1 in. in diameter at the end next the can, and tapers down in a length of 4 ft. to ½ in. As will be seen by the sketch, which shows the can in section, it has a barrel 1 in. in diameter in which works a plunger made of leather and secured to a ¼-in. rod with threaded end by two nuts and washers, one on each side. In addition to holding the leather piston in place these serve to keep it tight in the barrel, all that is necessary being to screw up the outer nut occasionally. The can is provided with a filling hole, covered by an ordinary zinc screw-cap, and has a handle on one side.



The oil is admitted to the barrel by a ¼-in. hole at *A*; this is kept closed by the plunger when the can is not in use, preventing oil from leaking into the barrel and wasting through the spout. The second ¼-in. hole at *B* is provided in order to dispose of any oil that might leak into the barrel behind the plunger; it also serves to aid the flow through the hole *A* when the plunger is drawn back.

The method of using this oiler will readily be understood. The advantage of keeping the center-plates oiled in reducing friction on curves is well understood; but on too many roads it is not done at all, and on others only irregularly and with but little care.

An Old Railroad.—By the courtesy of a gentleman in Birmingham who has a large collection of railway curiosities, we are enabled to give a representation of a medal referring to the Gloucester & Cheltenham Railway. The Act of Parliament under which that line was constructed was obtained in 1809, and was entitled "An Act for Making and Maintaining a Railway or Tramroad from the River Severn at the Quay in the City of Gloucester to or near a certain Gate in or near the Town of Cheltenham . . . called the Knapp Toll Gate, with a collateral branch to the Top of Leckhampton Hill." The preamble sets forth that the traffic between Cheltenham and Gloucester is very



AN OLD RAILROAD MEDAL.

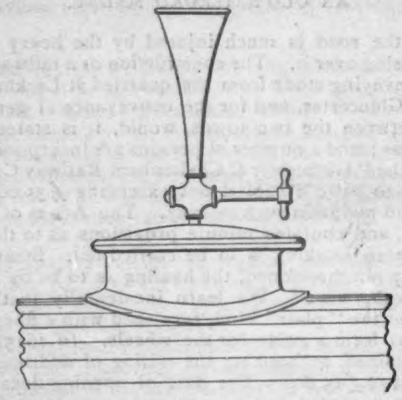
great, and the road is much injured by the heavy carts and wagons passing over it. The construction of a railway or tramroad for conveying stone from the quarries at Leckhampton to the port of Gloucester, and for the conveyance of general merchandise between the two towns, would, it is stated, be very advantageous; and a number of persons are incorporated under the title of the "Gloucester & Cheltenham Railway Company," with power to raise a capital not exceeding £35,000, and to construct and maintain such railway. The Act is of considerable length, and contains minute provisions as to the manner in which the undertaking is to be carried out. Steam-engines are naturally not mentioned, the hauling is to be by "men, or horses, or otherwise." We learn incidentally that the rails were to be of the "plate" kind, furnished with a flange on the outer side to form a guide for the wheels. In 1815 a further Act was obtained, authorizing the raising of additional capital to the extent of £15,000. The date of opening does not seem to have been recorded, but it appears to have been finished in 1819, as it is indicated in "a Geological Map of Gloucestershire," published in that year by the well known William Smith, "the father of English geology," as he has been well called. The line starts from Leckhampton, and joins the high road between Cheltenham and Gloucester, just outside the former town, whence it runs parallel to the road for some distance. About a mile from Gloucester it takes a curve, and enters the city at the opposite side. We are unable to give any information as to the object of the medal, or the date when it was struck. The locomotive is obviously of the *Agenoria* and *Stourbridge Lion* type, the former of which may be seen at South Kensington. They were built at Stourbridge, by Messrs. Foster & Rastrick, in 1828 and 1829 respectively, but the medal must certainly be subsequent to the accession of William IV., in 1830. It has been suggested that it was a first-class pass, perhaps issued to the directors, but if so, it would hardly have been struck in copper, as this is, and would not have been so large and heavy. A writer in the Local Notes and Queries column of the Birmingham *Weekly Post* of September 22, 1888, says that the tramway was in use some years after the present railway between Gloucester and Cheltenham was opened, and that in his boyhood he had many a ride upon the trucks which brought the stone from the quarries at Leckhampton. We believe that a portion of the tramway at the Leckhampton end is still in use.—*The London Engineer.*

A Physical Evil of Electric Welding.—A section of the men employed at the Kolomna Ironworks, in Russia, has lately had some unpleasant experiences with electric welding, which, with the aid of 500 accumulators, is there practised according to the Benardos process. While engaged on the trying work the artificers' eyes were, of course, protected by tinted glasses, but the skin being exposed, the following symptoms were manifested: Burning sensation on the skin and in the eyes; in from three to four hours, discharges from the nose

and the eyes; three to four hours later a dry cough; four to five hours later, swelling of the skin and development of other symptoms; eight to ten hours from the commencement of the disorder, continuous irritation of the eyes, lasting from four to six hours; and finally, coloring of the skin. Then the various effects ceased, and the skin began to peel. On the third day the cuticle had completely decorticated, and by the sixth all the painful symptoms disappeared. But for weeks afterward the skin remained colored. These effects, it would seem, are exactly the same as those which are induced under scorching by the sun. The best protection which can be afforded the workmen against the evils mentioned, M. Maklakoff, the Manager of the works, believes, consists in a covering of yellow waxed-cloth or red and green veils. The electric welders, however, object with characteristic Russian dignity to the assumption of the feminine facial appendages, alleging that although they may improve the general appearance of the fair sex, they will rather excite ridicule when they are worn by stalwart workers.—*Iron.*

The Locomotive Whistle.—Mr. Clement E. Stretton, C.E., writes to the *English Mechanic* as follows: "The invention of the first steam trumpet or whistle for locomotive engines has lately received much attention. The following facts and illustration may therefore prove of interest to your readers:

"During the first few weeks of the year 1833 the Leicester & Swannington Railway Company's engine, the *Samson*, ran into



THE FIRST LOCOMOTIVE WHISTLE.

a horse and cart crossing the line at the 'Stag and Castle,' Thornton, the cart being loaded with butter and eggs for the Leicester market.

"The engine-driver had only the usual horn, and could not attract attention. Mr. Ashlen Bagster, the Manager of the railway, went the same Saturday afternoon to Alton Grange, Snibstone, to report the circumstance to Mr. George Stephenson, who was one of the directors and the largest shareholder. After various ideas had been considered, Mr. Bagster remarked: 'Is it not possible to have a whistle fitted on the engine which steam can blow?' George Stephenson replied: 'A very good thought; go and have one made.' And such an appliance was at once constructed by a local musical-instrument maker. It was put on in ten days and tried in the presence of the board of directors, who congratulated both Bagster and Stephenson, and ordered more trumpets to be made for the other engines which the company possessed.

"The company had to pay for the horse and cart, 50 lbs. of butter and 1,000 eggs; after which strict instructions were issued that 'under no circumstances should any of the company's locomotive engines run unless fitted with the steam trumpet.'

"The annexed diagram is taken from the official drawing signed by Mr. H. Cabry, the company's Engine Superintendent, May, 1833."

Electric Locomotives in London.—In a recent paper Mr. A. Siemens has given some particulars in relation to the electric locomotives built by his firm for the City & South London underground road in London. These locomotives are mounted on four wheels and have a motor on each axle. The weight of the locomotive is 15½ tons, and the usual weight of train is 28 tons.

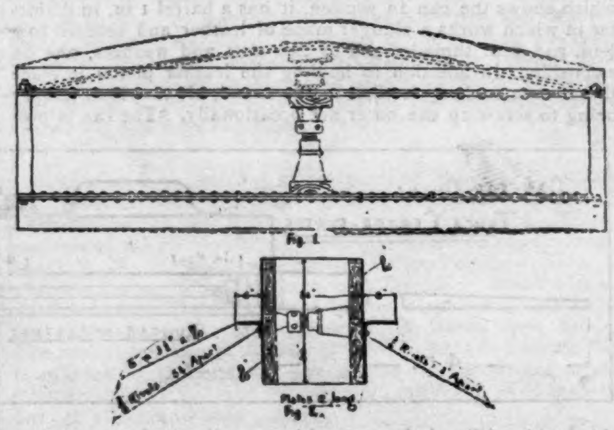
Careful experiments showed that at speeds varying from 12 to 30 miles an hour the power required varied from 53 to 120 H.P. The economic return was found to equal 92 to 94 per cent. of the power furnished. The current does not usually exceed 50 amperes, except in starting trains, when it sometimes rises to 140 amperes.

A New Gradient Indicator.—The firm of Brown Brothers, of Bristol, England, have recently brought out a self-adjusting gradient indicator for surveying, mining, and sanitary work, an illustration of which is given herewith. This instrument combines, in a convenient form, a set of spirit tubes, two of these being curved in such a manner that on application to any given surface the air bubble will become stationary opposite the point indicating the gradient of the surface to which it is applied. The long tube is used for all indications from 1 in 2

GRADIENT INDICATOR.

to 1 in 200 from horizontal positions, and has a point-showing level, the short tube being used for all vertical work, indicating by the position of the bubble gradients from 15° to plumb; thus, supposing the fall of surface to be 1 in 30, the bubble will float midway to the point marked 30 on the plate enclosing the long tube; or if a batter of, say, 45° is being tested, it will be found that the bubble is floating midway to a point marked 45° on the indicating plate enclosing the shortened tube upon the application of the instrument to the surface. It will thus be seen that the instrument indicates at a glance and without setting the inclination of a surface to which it is applied, and there are no parts to adjust or become worn.—*Industries.*

Bulkhead Stiffening.—The question of the efficiency of water-tight bulkheads under the strains brought to bear upon them through the compartments being flooded, in the event of damage to the hull of the vessel by collision, sunken rocks, or other causes, has called forth a great deal of careful thought. And in view of the many and diverse opinions, the experimental test lately carried out on behalf of Lloyd's under the supervision and direction of their surveyors, by Messrs. A. & J. Inglis, of the well-known ship-building firm of Pointhouse, Glasgow, is of great value, as giving some reliable data. In view of the introduction of flanged plates in place of the usual method of stiffening the bulkheads by angle-irons, Lloyd's gave instructions to prepare two test strips of bulkhead, as per fig. 2, to Messrs. A. & J. Inglis (to whom we are indebted for the illustration), which were each 12 ft. long and 30 in. wide, the one being of the usual design, consisting of a plate 0.4 in. thick, stiffened by an angle iron 6 in. × 3½ in. × ½ in. riveted on by rivets ¾ in. in diameter and 5¼ in. apart; the other was of the flanged plate design, and consisted of two plates 0.4 in. thick, the edge of the one being flanged out 8 in. and the two plates riveted together with rivets ¾ in. in diameter and 3 in. apart. The two strips were rigidly connected at the ends, and were forced apart with a screw-jack placed between them in the center. It was found that the strip of bulkhead stiffened by the angle iron gave way, as shown by the dotted lines in fig. 1, while that stiffened by the flanged plate had practically retained its position, the deflection being very slight. This power of resistance is of most vital importance, as even the straining of the bulkheads by the weight of the cargo resting against them when the opposite side is not similarly supported, too often renders them useless as a water-tight bulkhead, and they become simply partitions for cargo purposes.—*Shipping World.*



TESTS OF BULKHEAD BRACING.